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Contents

Contents of previous issues can be found by consulting the Industrial Arts Index at your library

• Special Articles

A Study of the Incidence of Shrinkage in Women's and Children's Wearing Apparel Fabrics..... 405
Anne Brohel Searle with Pauline Beery Mack

Consumer Classification and Specifications for Cotton Broadcloth 410
Gladys White and Margaret B. Hays

A Specialized Treatment of Discarded Paper-Maker's Felts and a Possible Method of Conditioning for Reclaiming the Wool..... 437
Leo Gleklen

• Departments

Trade Notes—New Products..... 439

• Proceedings of the American Association of Textile Chemists and Colorists

Tentative Program, Nineteenth Annual Meeting..... P411

Electrophoretic Studies of Silk..... P412
Arnold M. Sookne and Milton Harris

The Evaluation of Finishing Treatments — Progress Report P417

Correction Re: Printing Pastes..... P418

The Evaluation of Wetting Agents..... P419
Joseph W. Creely and George LeCompte

A Consideration of the A.A.T.C.C. Official and the Canvas Disc Methods for the Evaluation of Wetting Agents P421
Carl Z. Draves

Evaluation of Wetting Agents: Official Method..... P425
Carl Z. Draves

One Hundred and Sixteenth Meeting of the Research Committee P428

One Hundred and Twenty-Third Council Meeting..... P428

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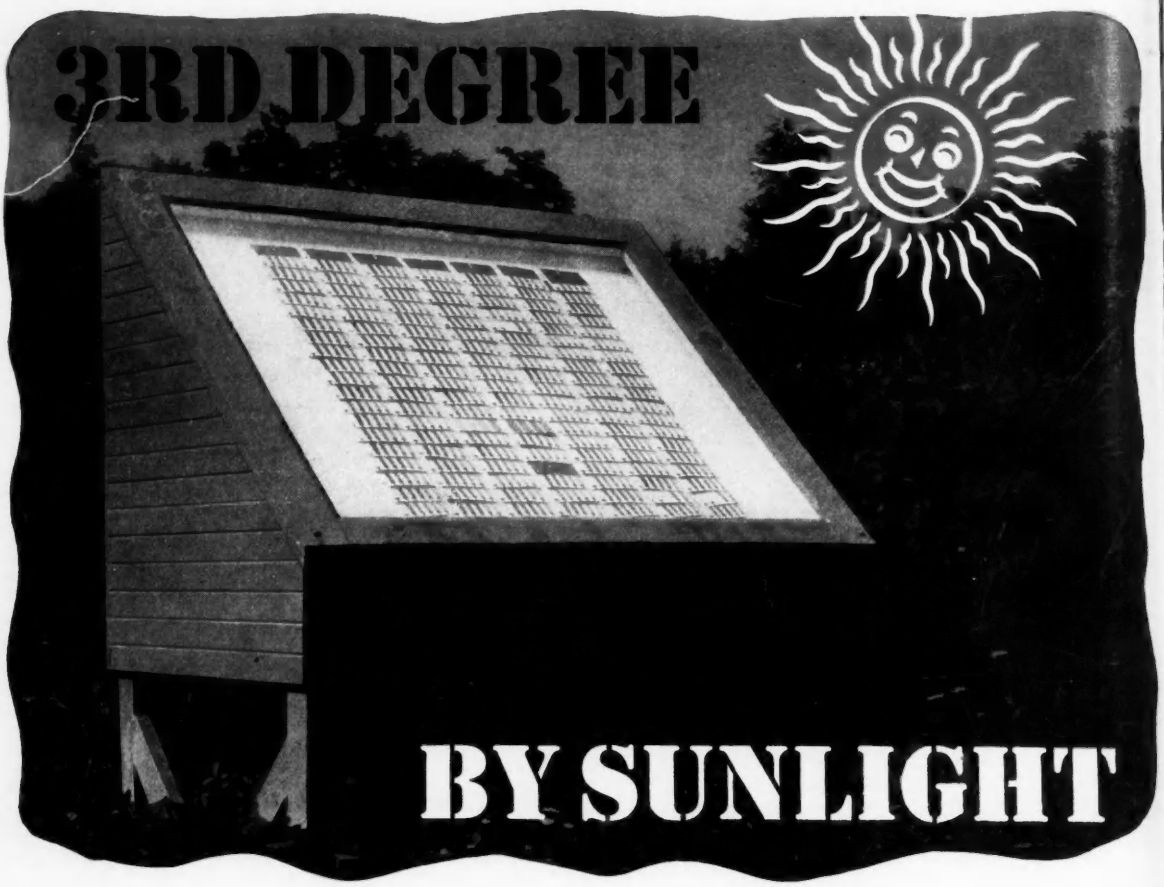

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A Study of the

Incidence of Shrinkage

in Women's and Children's Wearing Apparel Fabrics[1]

ANNE BROHEL SEARLE with PAULINE BEERY MACK*

SHRINKAGE in textile fabrics is a cause of dissatisfaction to consumers and of damage claims in laundry and drycleaning establishments. With the passage of a trade practice ruling by the Federal Trade Commission on June 30, 1938, on Shrinkage of Woven Cotton Goods, a statement of the guaranteed maximum residual shrinkage is now required to accompany all written claims denoting that a woven cotton fabric is pre-shrunk or non-shrinkable, although no such labelling need be used on a cotton fabric of which no assertions have been made as to pre-shrinkage. On the other hand, no regulations of any kind have been made concerning fabrics intended for rehabilitation by the drycleaning process.

The study reported in this paper has to do with the incidence of shrinkage in 570 women's and children's wearing apparel fabrics collected from consumers between September, 1936, and September, 1938. Most of the fabrics had been purchased in retail markets before the aforementioned Federal Trade Commission ruling on shrinkage in woven cotton goods had gone into effect. The study had two purposes:

(1) to obtain information on the shrinkage performance of a wide variety of fabrics purchased by retail consumers, including types which are ordinarily drycleaned, as well as those which are laundered;

(2) to ascertain the accuracy of retail sales information on the shrinkage characteristics of common textile fabrics.

A continuance of the study will make it possible to ascertain the influence of the Federal Trade Commission ruling on the shrinkage performance of woven cotton goods and also will relate the shrinkage characteristics of fabrics to their constructional types.

The textile materials used in the study were obtained in connection with a long-time co-operative project on the durability of women's and children's wearing apparel fabrics purchased on the retail market, which is in progress in the Northeastern Experiment Stations, with Maryland, New Hampshire, New Jersey, New York, Pennsylvania, and Rhode Island participating.[2]

METHOD OF OBTAINING SALES INFORMATION

Sales information was obtained by the purchasers who submitted the fabrics for the study. Each purchaser was provided with a uniform set of questions about which sales information should be sought concerning each fabric purchased. The answers to these questions were obtained either orally or in writing whenever a purchase was made in a retail store; the latter type of information was obtained from labels, store placards, or display signs. Information on fabrics which were secured from mail-order houses was obtained from catalogs, insofar as it

*The Pennsylvnaia State College.

[1] Authorized on November 25, 1938, for publication in the American Dyestuff Reporter as Paper Number 2 of the Co-operative Textile Series, Division of Home Economics Research, The Pennsylvania State College; authorized January 11, 1938, as Paper Number 887 in the Journal Series of The Pennsylvania Agricultural Experiment Station.

A part of the data presented in this paper was taken from a thesis submitted by the junior author in partial fulfilment of the requirements of the M. S. degree in Home Economics at The Pennsylvania State College, August, 1937, working under the direction of the senior author. The co-operative project described in this paper is directed by a committee of staff members from the participating experiment stations, as follows: Maryland, Polly Bell Kessinger; New Hampshire, Daisy Williamson; New Jersey, Inez La Bossier; New York, Beulah Blackmore; Rhode Island, Blanche Kuschke; and Pennsylvania, Pauline Beery Mack, chairman. The authors are indebted to Esther Naomi Chapman for valuable help in carrying on this study.

[2] *Co-operative Project in Textiles Conducted by the Northeastern Experiment Stations*, by Anne Brohel Searle, Esther Naomi Chapman, and Elizabeth Douglass Roseberry, Journal of Home Economics, Volume 31, Number 3, pp. 177-184 (March, 1939).

was available. In all cases, an earnest effort was made to secure answers to all of the questions asked about each fabric. The questions dealt with many characteristics related to durability and performance; this report, however, contains an analysis of the information related to shrinkage only.

A record was made of all sales statements concerning shrinkage, both oral and written, so that the accuracy of these statements might be ascertained by means of laboratory tests.

LABORATORY TESTS FOR SHRINKAGE

Drycleaning Tests. The drycleaning tests were carried out according to the procedure recommended in Commercial Standard 59-36, paragraph XII[3]. According to this method of test, two procedures were followed. The first of these, called the *drycleaning test by the dry method*, was used to determine the shrinkage performance of fabrics during the ordinary drycleaning process. The second, designated as the *drycleaning test by the wet method*, is intended to show the shrinkage of fabrics when they must be sponged with water in the removal of water-borne stains, whether on small or large areas of the fabric. The use of water in spot removal or in general sponging is necessary in the drycleaning of most fabrics which reach the drycleaning plants, if any but oil-soluble stains are to be removed. The use of water upon a fabric while it is wet with one of the common drycleaning solvents, as carried out in most cleaning plants and as prescribed in this test, has been found in the laboratory of the authors and elsewhere to produce a lower degree of shrinkage than washing or sponging the fabric with water, without first drycleaning it, in the majority of cases.

Laundering Tests. In making tests for shrinkage performance during laundering, the method outlined in Commercial Standard 59-36, paragraph XIII, was followed.

The test fabrics in both the drycleaning and the laundering procedures were dried by the method prescribed, on a wooden frame covered with copper screen over which a white canvas was stretched.

Whether a drycleaning or a laundering test was used with a specific fabric was decided by the authors on the basis of the method of refreshment which appeared to be suitable from recommendations given in labels, or from the type of the fabric itself.

SUMMARY OF FINDINGS

As mentioned, a total of 570 fabrics was included in this study, of which 269 were tested for shrinkage performance during the two drycleaning tests, and 301 for that during the laundering test. In Table I, A and B, the drycleaning and laundering results are reported first for all of the fabrics given these treatments, and later for each of the major types of fabrics separately, (grouped on the basis of fiber content). In the two dry cleaning tests the respective numbers of samples of each were the following: woolen, 48; pure dye silk, 37; weighted silk, 14; viscose rayon, 67; cellulose acetate rayon, 12; cuprammonium rayon, 4; mixed viscose and cellulose acetate rayon, 48; cotton fabrics, 5; and miscellaneous fabrics, 34.

An arbitrary value of two per cent or under in the direction of greater shrinkage of the fabric was considered as residual shrinkage sufficiently low as to insure satisfaction insofar as this factor is concerned, and fabrics with as little shrinkage as this amount are reported as not shrinking. Fabrics which shrank more than two per cent in either direction during the tests are reported as shrinking. The number of fabrics which showed stretching during the tests was so small, and the degree of stretchage was so slight in all cases, that these fabrics were not reported separately in the analyses of results; such fabrics, however, are reported as not shrinking.

In Figure IA, as well as in Table IA, just cited, is presented the percentage of these fabrics shrinking two per cent or under—the arbitrary value set by the authors as denoting satisfactory performance in this respect. It is shown that the percentage of satisfactory performance during the drycleaning test by the dry method was 56.1 per cent for all of the fabrics; the percentage of satisfactory performance during the drycleaning test by the wet method was 6.6 per cent. The percentage of satisfactory performance with respect to shrinkage in both the dry and the wet drycleaning tests was highest in the 100 per cent cellulose acetate fabrics, all of which were flat weaves. The lowest percentage of satisfactory performance in both of these tests was found among the acetate and viscose rayon mixed fabrics, most of which were crepe weaves.

It is understood by the authors that the type of weave used in constructing a fabric is one of the most important factors involved in shrinkage. Hence, the results reported here are not intended to indicate that the fiber content is the sole, or even the chief variable to be considered in this case. In the present study, a variety of fabrics was examined for incidence of shrinkage and degree of accuracy of sales information concerning this characteristic. In studies to be reported later, the construction of fabrics in relation to shrinkage is being investigated in considerable detail.

In the table and figure under consideration, it is seen that performance of the fabrics during the drycleaning test by the wet method was vastly inferior to that during the tests by the dry method. The necessity for using water at least to a limited degree with practically every garment which reaches a drycleaning plant has been pointed out earlier in this report. Consideration therefore could well be given to this fact by the manufacturer and finisher of fabrics which are to be refreshed by the drycleaning process.

In Table IB and in Figure IB are shown the percentages of laundered fabrics performing satisfactorily during the laundering test. The fabrics tested for shrinkage performance during laundering were not the same ones which were tested for drycleaning performance, as was mentioned earlier, but were those fabrics in the study which ordinarily are refreshed by laundering. In all, 301

[3]United States Commercial Standard 59-36 for Testing and Reporting Woven Dress Fabrics, United States Printing Office, April 15, 1936.

TABLE I

GENERAL ANALYSIS OF DATA ON SHRINKAGE

A. DRYCLEANED FABRICS

Type of Fabric	Number of fabrics tested for shrinkage during dry-cleaning	Number of these said to be pre-shrunk, or non-shrinkable	Number said not to be pre-shrunk, or non-shrinkable	Number of fabrics about which no information on shrinkage was given	Number of fabrics represented as pre-shrunk, or nonshrinkable found incorrectly described according to the 2% standard: Drycleaning test by dry method	Drycleaning test by wet method	Number of fabrics found by test to have a shrinkage of 2% or under regardless of representations: Drycleaning test by dry method	Drycleaning test by wet method	Number of fabrics found by test to show shrinkage in excess of 2%, regardless of representations: Drycleaning test by dry method	Drycleaning test by wet method	Upper, and lower limits of shrinkage, and averages: Drycleaning Test by Dry Method: High	Low	Average	Drycleaning Test by Wet Method: High	Low	Average
All fabrics tested for drycleanability	269	61 (22.6%)	23 (8.6%)	185 (68.8%)	30 (49.2%)	57 (93.4%)	151 (56.1%)	18 (6.6%)	118 (43.9%)	251 (93.3%)	W)11.2 F)17.4	0.0 0.0	1.8 1.9	W)28.9 F)32.5	0.0 0.0	7.0 7.8
Wool	48	15 (31.3%)	5 (10.4%)	28 (58.3%)	7 (46.7%)	13 (86.7%)	26 (54.2%)	3 (6.3%)	22 (45.8%)	45 (93.8%)	W) 7.3 F) 8.3	0.0 0.0	2.2 1.6	W)11.5 F)15.0	0.6 0.0	6.6 4.8
Pure dye silk	37	12 (32.4%)	2 (5.4%)	23 (62.2%)	9 (75.0%)	12 (100.0%)	18 (48.6%)	2 (5.4%)	19 (51.4%)	35 (94.6%)	W)11.2 F) 9.5	0.0 0.0	2.6 1.8	W)16.7 F)23.0	1.0 0.0	7.2 6.6
Weighted Silk	14	2 (14.3%)	0 (0.0%)	12 (85.7%)	1 (50.0%)	2 (100.0%)	10 (71.4%)	2 (14.3%)	4 (28.6%)	12 (85.7%)	W) 2.7 F) 4.9	0.0 0.0	0.6 1.2	W) 7.2 F)10.0	1.2 0.2	3.4 5.4
Rayon made by viscose process	67	15 (22.4%)	4 (6.0%)	48 (71.6%)	5 (33.3%)	14 (93.3%)	50 (74.6%)	3 (4.5%)	17 (25.4%)	64 (95.5%)	W) 6.0 F) 8.7	0.0 0.0	1.1 1.1	W)14.0 F)19.5	0.0 0.0	6.9 4.6
Rayon made by cellulose acetate process	12	3 (25.0%)	1 (8.3%)	8 (66.7%)	0 (0.0%)	2 (66.7%)	12 (100.0%)	6 (50.0%	0 (0.0%)	6 (50.0%)	W) 1.5 F) 0.9	0.0 0.0	0.5 0.1	W) 4.4 F) 2.3	1.3 0.0	2.3 0.9
Rayon made by cuprammonium process	4	0 (0.0%)	0 (0.0%)	4 (100.0%)	0 (0.0%)	0 (0.0%)	2 (50.0%)	0 (0.0%)	2 (50.0%)	4 (100.0%)	W) 3.4 F) 3.4	0.0 0.0	1.8 0.9	W) 8.7 F) 3.1	2.5 0.2	6.5 1.7
Acetate and viscose mixed rayons	48	8 (16.7%)	7 (14.6%)	33 (68.8%)	6 (75.0%)	8 (100.0%)	11 (22.7%)	0 (0.0%)	37 (77.1%)	48 (100.0%)	W) 5.1 F)17.4	0.0 0.0	2.6 5.0	W)28.9 F)32.5	2.2 1.3	10.4 21.3
Cotton	5	0 (0.0%)	0 (0.0%)	5 (100.0%)	0 (0.0%)	0 (0.0%)	3 (60.0%)	1 (20.0%)	2 (40.0%)	3 (60.0%)	W) 2.8 F) 3.9	0.0 0.0	0.9 1.3	W) 3.8 F) 8.5	0.0 0.0	1.8 1.8
Miscellaneous fabrics	34	6 (17.6%)	4 (11.8%)	24 (70.6%)	2 (33.3%)	6 (100.0%)	19 (55.9%)	1 (2.9%)	15 (44.1%)	33 (97.1%)	W) 4.5 F) 6.5	0.0 0.0	1.7 1.2	W)12.8 F)25.4	0.6 0.5	6.5 5.6

B. LAUNDERED FABRICS[1]

Type of Fabric	Number of Fabrics Tested for Shrinkage During Laundering	Number of These Said to be Pre-Shrunk or Non-Shrinkable	Number Said Not to be Pre-Shrunk or Non-Shrinkable	Number of Fabrics About Which no Information on Shrinkage was Given	Number of Fabrics Represented as Pre-Shrunk or Non-Shrinkable, Found Incorrectly Described According to the 2% Standard	Number of Fabrics found by Test to have a Shrinkage of 2% or Under Regardless of Representation	Upper and Lower Limits of Shrinkage and Averages	Upper and Lower Limits of Shrinkage, and Averages: High	Low	Average
All Fabrics Tested for Launderability	301	98 (32.6%)	33 (11.0%)	170 (56.5%)	85 (86.7%)	69 (22.9%)	232 (77.1%)	W)16.6% F)16.6%	0.0 0.0	4.1 3.6
Cotton	222	61 (27.1%)	27 (12.2%)	134 (60.4%)	56 (91.8%)	14 (6.3%)	208 (93.7%)	W)16.6% F)16.6%	0.0 0.0	4.6 4.3
Pure Dye Silk	13	6 (46.2%)	0 (0.0%)	7 (53.8%)	5 (83.3%)	5 (38.5%)	8 (61.5%)	W) 7.6% F) 7.3%	0.1 0.5	3.5 2.9
Rayon made by the Viscose Process	54	24 (44.4%)	4 (7.4%)	26 (48.1%)	14 (58.3%)	17 (31.5%)	37 (68.5%)	W) 7.0% F) 5.0%	0.0 0.0	2.4 0.9
Miscellaneous Fabrics	12	7 (58.3%)	2 (16.7%)	3 (25.0%)	6 (85.7%)	3 (25.0%)	9 (75.0%)	W)11.9% F)11.6%	0.3 0.4	3.6 2.7

(1) Each fabric was tested for launderability by the standard test method recommended for the type of material which it represented.

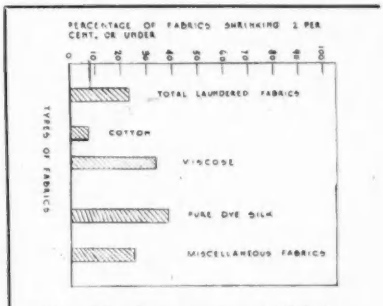
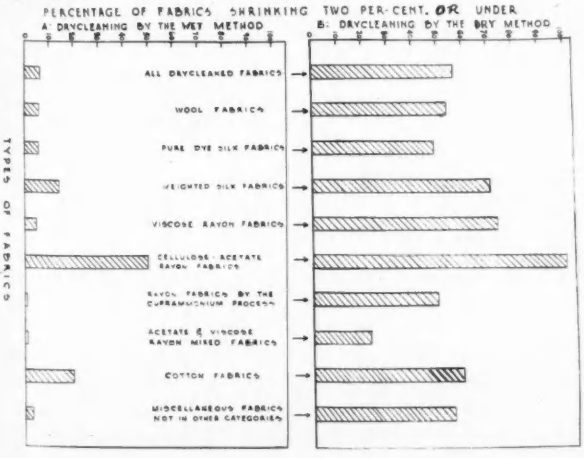


Fig. IB—Percentage of Fabrics of Different Fiber Content Groups Shrinking two per cent or less during the Laundering Tests.

Fig. IA—Percentage of Fabrics of Different Fiber Content Groups Shrinking two per cent or less during the Dry Cleaning Tests.



fabrics were tested for shrinkage during laundering, of which 222 were cotton (including 11 linen fabrics sent to the laboratory in error for cotton); 13 were pure dye silk; 54 were viscose rayon; and 12 were of miscellaneous fibers.

It is seen from the table and figure that, of all of the laundered fabrics, only 22.9 per cent came within the arbitrary standard of satisfactory shrinkage performance set in this study—namely, shrinking no more than two per cent in either direction during the test. The pure dye silk washable fabrics exhibited the highest degree of satisfactory performance during this test, and the cotton fabrics the lowest. (Note: Low durability of weighted silk is such as not to recommend weighting as a means of reducing shrinkage in silk.)

In Table II, percentages are given; (1) for the fabrics which were described accurately with respect to shrinkage, (2) for those which were described inaccurately, and

TABLE II

PERCENTAGE OF CORRECT SALES INFORMATION GIVEN ABOUT THE FABRICS

A. DRYCLEANED FABRICS

Type of Fabric	Accurate		Inaccurate		No Information
	Drycleaning Test by the Dry Method	Drycleaning Test by the Wet Method	Drycleaning Test by the Dry Method	Drycleaning Test by the Wet Method	
All Fabrics Tested for Drycleanability	15.6%	10.0%	15.6%	21.2%	68.8%
Wool	22.9%	14.6%	18.8%	27.1%	58.3%
Pure Dye Silk	10.8%	6.4%	27.0%	32.4%	62.2%
Weighted Silk	7.1%	7.1%	7.1%	7.1%	85.7%
Rayon made by the Viscose Process	16.4%	6.0%	12.0%	22.4%	71.6%
Rayon made by the Cellulose Acetate Process	33.3%	16.6%	0.0%	16.6%	66.7%
Rayon made by the Cuprammonium Process	x	x	x	x	100.0%
Acetate and Viscose Mixed Rayons	10.4%	14.6%	20.8%	16.6%	68.7%
Cotton	x	x	x	x	100.0%
Miscellaneous Fabrics	17.6%	11.8%	11.8%	17.6%	70.6%

B. LAUNDERED FABRICS

Type of Fabric	Accurate	Inaccurate	No Information
All Fabrics Tested for Launderability	16.3%	27.2%	56.5%
Cotton	14.4%	25.2%	60.3%
Pure Dye Silk	7.7%	38.5%	53.8%
Rayon made by the Viscose Process	24.2%	27.7%	48.2%
Miscellaneous Fabrics	25.0%	75.0%	25.0%

(3) for those about which no information was obtainable. This information is given first about the drycleaned fabrics, including response to the drycleaning tests by both the dry and the wet method, and then about the laundered fabrics. The data for the drycleaned fabrics are shown graphically in Figure IIA, and for the laundered fabrics in Figure IIB.

From the data and the figures, it is apparent that no information was given about most of the fabrics as far as their probable shrinkage performance was concerned. In the case of the response to drycleaning by the dry method, the percentages of accurate and of inaccurate descriptions are the same, whereas the percentage of accurate statements concerning response to the wet drycleaning process was less than half of the percentage of inaccurate statements. It should be stated that separate questions at the time of purchase were not asked about response to the dry and to the wet methods of drycleaning, but it was assumed for purposes of the study that a fabric should be able to respond satisfactorily to either treatment for it to qualify as not shrinking during drycleaning. The greater degree of accuracy of the sales information concerning drycleaning by the dry method was due to the more satisfactory response of the fabrics to this test.

No information was given about the shrinkage performance of most of the laundered fabrics. The number of fabrics within each of the fiber content groups about which no information was given was greater than that of those either accurately or inaccurately described. The number of fabrics not described as to shrinkage during laundering, moreover, was smaller than that of the ones not described during drycleaning. The number of fabrics described inaccurately with respect to the characteristic under consideration was greater for every group of fabrics than the number which was described accurately.

In Table III, all of the fabrics about which shrinkage

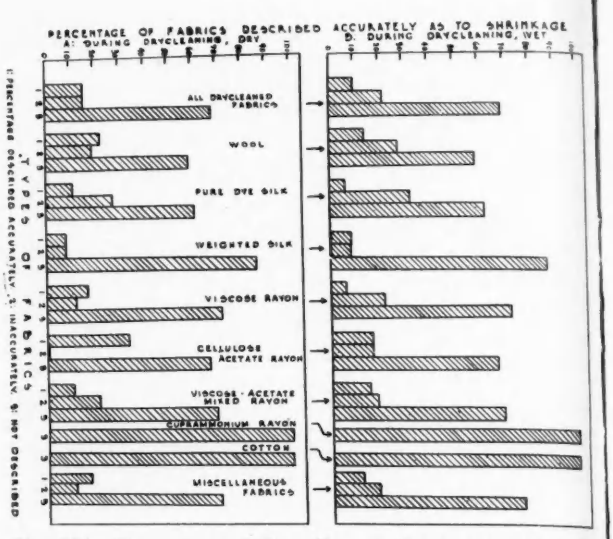


Fig. IIA—Percentage of Dry Cleaned Fabrics about which Accurate, Inaccurate or no Sales Information was given.

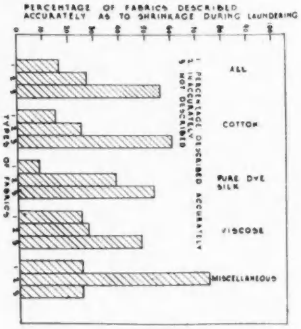


Fig. IIB — Percentage of Laundered Fabrics about which Accurate, Inaccurate, or no Sales Information was given.

information was given are taken into consideration, and the percentage accuracy of the information secured orally is compared with that given in writing. With both the drycleaned and laundered fabrics combined, 214 (32 per cent of the total) were described as to shrinkage attributes, of which 201 were described orally and only 13 fabrics (or six per cent of those described as to shrinkage performance) were so described in writing. The number of the latter was so small that no significant differences in the percentages of accurate descriptions given orally or in writing were obtained. It is to be noted that, of the 13 fabrics labeled or described on placards as preshrunk, or by a similar term, only three came within the tolerances for satisfactory performance in this report.

In Figures IIIA and IIIB, the percentage of fabrics represented as pre-shrunk or non-shrinkable, which were found to shrink more than the tolerance set in this report permitted (two per cent in the direction of the greater shrinkage), is compared with that of fabrics represented as not pre-shrunk or non-shrinkable, but found not to shrink within the arbitrary limits which have been defined. In these figures, groups of fabrics about which none of the information was inaccurate are represented by a line superimposed over the base line, while groups

TABLE III

COMPARISON OF ACCURACY OF SALES INFORMATION GIVEN IN ORAL WITH THAT GIVEN IN WRITTEN FORM

A. DRYCLEANED FABRICS[1]

Type of Fabric	Number of Fabrics described as to Shrinkage, about which Shrinkage Information was Oral	Number of Fabrics described as to Shrinkage, about which Shrinkage Information was Written	Number of Fabrics about which Oral Shrinkage Information was Accurate		Number of Fabrics about which written Shrinkage Information was Accurate	
			Dry Cleaning Test by the Dry Method	Dry Cleaning Test by the wet Method	Dry Cleaning Test by the Dry Method	Dry Cleaning Test by the wet Method
All Fabrics Tested for Drycleanability	79 (96.4%)	3 (3.6%)	39 (49.4%)	17 (21.5%)	2 (66.6%)	1 (33.3%)
Wool	19 (95.0%)	1 (5.0%)	9 (47.4%)	1 (5.3%)	1 (100.0%)	1 (100.0%)
Pure Dye Silk	13 (100.0%)	0 (0.0%)	3 (23.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Weighted Silk	2 (100.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Rayon made by the Viscose Process	18 (94.7%)	1 (5.3%)	11 (61.2%)	4 (22.2%)	0 (0.0%)	0 (0.0%)
Rayon made by the Cellulose Acetate Process	4 (100.0%)	0 (0.0%)	4 (100.0%)	2 (50.0%)	0 (0.0%)	0 (0.0%)
Acetate and Viscose Mixed Rayons	14 (100.0%)	0 (0.0%)	6 (42.8%)	6 (42.8%)	0 (0.0%)	0 (0.0%)
Miscellaneous Fabrics	9 (90.0%)	1 (10.0%)	5 (55.5%)	5 (45.5%)	1 (100.0%)	0 (0.0%)

1) No information about shrinkage was given about Cuprammonium or the cotton fabrics of the drycleanable group.

B. LAUNDERED FABRICS

Type of Fabric	Number of Fabrics described as to Shrinkage, about which Shrinkage Information was Oral	Number of Fabrics described as to Shrinkage, about which Shrinkage Information was Written	Number of Fabrics about which Shrinkage Information was Accurate	Number of Fabrics about which written Shrinkage Information was Accurate
All Fabrics Tested for Launderability	122 (92.5%)	10 (7.5%)	73 (59.8%)	1 (10.0%)
Cotton	80 (89.9%)	9 (10.1%)	31 (38.8%)	1 (11.1%)
Pure Dye Silk	6 (100.0%)	0 (0.0%)	1 (16.7%)	0 (0.0%)
Rayon made by the Viscose Process	27 (96.5%)	1 (3.5%)	9 (33.3%)	0 (0.0%)
Miscellaneous Fabrics	9 (100.0%)	0 (0.0%)	2 (22.2%)	0 (0.0%)

about which no information was obtained on the particular question are designated by a line above which there is an (x).

These figures show clearly that only a few of the fabrics represented as not pre-shrunk or non-shrinkable were inaccurately described, whereas a large percentage of those represented as pre-shrunk or non-shrinkable were not described correctly. The greater tendency toward error in sales information concerning shrinkage, therefore, was in the direction of describing fabrics as better with respect to a low residual shrinkage than the facts justified.

SUMMARY AND CONCLUSIONS

The foregoing report deals with the shrinkage performance of 570 fabrics purchased in retail markets for use in making women's and children's garments. The study has shown the following:

(1) Of all the fabrics tested for shrinkage performance during drycleaning, 56.1 per cent of the fabrics shrank two per cent or less in the direction of the greatest shrinkage during the drycleaning test by the dry method, but only 6.6 per cent of the fabrics performed with the same degree of satisfaction when subjected to the drycleaning test by the wet method. The significance of the latter method in the drycleaning process has been emphasized in the body of this report.

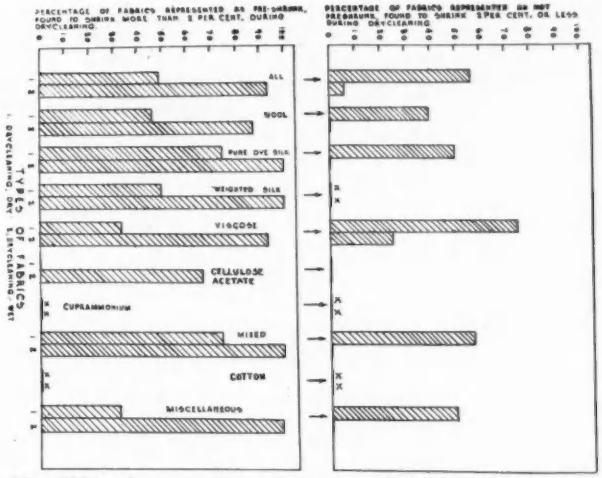


Fig. IIIA—A comparison of the Dry Cleaned Fabrics represented as Pre-Shrunk or Non-Shrinkable which were found to shrink within the Tolerance of the Study, with those represented as not Pre-Shrunk but which were found not to shrink.

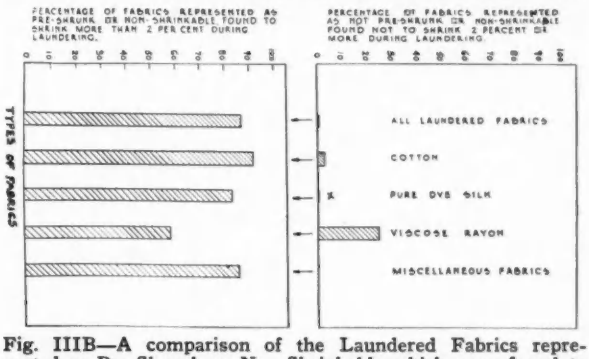


Fig. IIIB—A comparison of the Laundered Fabrics represented as Pre-Shrunk or Non-Shrinkable which were found to shrink within the Tolerance of the Study, with those represented as not Pre-Shrunk but which were found not to shrink.

(2) Of all of the fabrics tested for shrinkage during laundering, 22.9 per cent shrank two per cent or less.

(3) No information was given about 68.8 per cent of the fabrics ordinarily refreshed by drycleaning, nor about 56.6 per cent of the fabrics refreshed by laundering.

(4) The same percentage of accuracy as of inaccuracy was found in the statements concerning drycleaned fabrics when the fabrics were tested by the dry drycleaning method, but the percentage of inaccurate information was greater than that of accurate information when the fabrics were tested by the wet drycleaning process.

(5) The percentage of inaccuracy of information concerning the shrinkage behavior of the laundered fabrics was greater than that of accuracy.

(6) Of the 570 fabrics, 32 per cent were described by the sales agent as to shrinkage performance. Of these, only six per cent were described in writing, such as on labels or on placards. Of those described in writing only three fabrics, or 23 per

(Concluded on page 439)

Consumer Classification and Specifications for

Cotton Broadcloth*

GLADYS WHITE† and MARGARET B. HAYS**

INTRODUCTION

THE widespread use of cotton broadcloth for shirting, women's uniforms, and for many other purposes makes it one of the most important staple clothing fabrics. Broadcioth was originally a high quality material made in only a few constructions. but today many of the varied constructions on the market labeled or sold as broadcloth are of such poor quality that the name should not be applied to them. However, consumers generally believe that all of the so-called broadcloths are of high quality and expect to find certain characteristics in these fabrics. They, therefore, are often confused and disappointed in their purchases. Because true broadcloth is in danger of losing its popularity, the Bureau of Home Economics made the present study in order to define the term and to set up buying guides for consumers.

*Acknowledgment is made to Richard S. Hunter, of the Colorimetry Section, National Bureau of Standards, for measurements of apparent reflectance contrast; to Lillian Sillano, junior scientific aide, Division of Textiles and Clothing for measurements of yarn twists and of barium hydroxide absorption; and to Delia Ann Taylor, scientific aide, Division of Textiles and Clothing, for determinations of yarn number. Appreciation is also expressed to K. H. Barnard, of the Pacific Mills, Lawrence, Massachusetts, who furnished unmercerized broadcloth for standards in the mercerization tests.

According to testimony given before the Federal Trade Commission in 1924[1], the so-called "English broadcloth" as introduced into this country in 1919 was made from the finest grade of Egyptian long staple cotton yarns. These yarns were 2-ply in both the warp and filling. The yarn numbers were 100 in both directions, and the yarn counts ranged from 144 x 76 to 156 x 84. The fabric became very popular, especially as a shirting material. However, about the middle of the year 1921 similar fabrics of inferior yarns appeared. These were offered in various grades and were made by both English and American mills.

Hoye[2] summarizes the characteristics of broadcloth now on the market in the following manner: It has a rib effect somewhat similar to poplin. Yarn numbers run from 30 to 50 in the warp for single yarns and 80 to 100 for ply yarns; from 40 to 60 in the filling for single yarns and 120 for ply yarns. The yarn counts for carded single yarns range from 80 x 56 to 128 x 68, for combed single yarns from 96 x 60 to 144 x 76, and for combed ply yarns from 128 x 68 to 164 x 84. The fabrics with combed yarns are usually mercerized, while those with carded yarns are calendered. Most broadcloths are given a preshrinkage treatment.

PREVIOUS PUBLISHED RESULTS

Few data have been published on analyses of the physical properties of cotton broadcloth. Phelps and Gorham[3] analyzed 11 popular priced white broadcloth shirts. Three of these shirts had 2-ply yarns in both directions, one had 2-ply warp and single filling yarns, and the other seven had single yarns in both the warp and the filling. The study showed considerable variation in the properties of fabrics used in broadcloth shirts selling at about the same price. From a similar analysis of the physical characteristics of six broadcloth shirts of different prices, Griffith and Siegert[4] reported a correlation between price and quality.

Larmore[5] compared the two different types of fabrics, poplin and broadcloth, to evaluate their relative serviceability. She concluded that poplin was more satisfactory than broadcloth because of less shrinkage, greater durability as judged by physical characteristics, and less variability among its physical properties.

Three broadcloths were tested by Griffith and Strow[6] who found a close relationship between the weight, thickness, and the price of these. Marker and Cranor[7] compared the wearing quality of fabrics as determined by their physical characteristics. One sample of broadcloth was compared with eight different white cotton fabrics. The general conclusion was that quality cannot be determined by testing merely the strength of a fabric and its resistance to abrasion.

EXPERIMENTAL WORK

The present study was made to determine differences in the physical properties of various broadcloth constructions and to examine the effect of these properties on the quality of the materials. Fifty-one fabrics were purchased from manufacturers, retail stores, and mail order houses in the period between October, 1936, and May, 1938. These representative qualities of broadcloth were analyzed for yarn number, twist, yarn count, weight, thickness, breaking strength, bursting strength, amount of shrinkage,

(Continued on page 431)

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PROCEEDINGS OF THE

American Association of Textile Chemists and Colorists

AUGUST 7, 1939

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Tentative Program

Nineteenth Annual Meeting

Friday, September 15

Register on arrival. Lobby, Copley Plaza Hotel.

Morning:

Meeting of the Council and Research Committee.

Noon:

Luncheon for Research Committee and Council.

2 *p.m. to* 5 *p.m.*

Technical papers. Main Ballroom, Copley Plaza Hotel

6:30 *p.m.*

Buffet supper, followed by formal opening of the convention and entertainment, in Main Ballroom, Copley Plaza Hotel.

Saturday, September 16

9:30 *a.m. to* 12:30 *p.m.*

Technical papers. Main Ballroom, Copley Plaza Hotel.

12:30 *p.m.*

Luncheon for National and Sectional officers and Research Committee.

Afternoon

Sight-seeing. For those who wish to play golf, arrangements have been made at three golf courses to accommodate them.

7:00 *p.m. sharp*

Annual banquet. Main Ballroom, Copley Plaza Hotel.

If you can arrange to do so, bring your ladies along. A Ladies' Bridge Tournament has been arranged for Friday afternoon. Ladies may attend the buffet supper Friday night together with the opening of the convention and the entertainment. Places will be available for the ladies in the balcony of the Main Ballroom for the speaking program after the annual banquet.

Boston affords many facilities for sight-seeing (both historical and modern), recreation, and shopping so there are plenty of opportunities for the ladies to enjoy their stay.

Electrophoretic Studies of Silk

ARNOLD M. SOOKNE and MILTON HARRIS*

ABSTRACT

A micro-electrophoretic technique was used to determine the characteristic pH-mobility curves for fibroin and for sericin and to ascertain the extent of removal of the latter during degumming by the soap and enzyme processes. The data suggest that sericin contains a much greater proportion of reactive groups than fibroin, and indicate the importance of obtaining either uniform or complete removal of sericin during degumming processes.

The isoelectric points are shown to vary slightly wtih ionic strength. In acetate buffers of 0.02 *M* ionic strength, the isoelectric point of fibroin is 3.6 and that of sericin 4.3.

Large ions of complex structure such as phthalate or picrate appear to have specific effects which are readily detectable by the electrophoretic technique.

Dissolved fibroin adsorbed on glass particles and fibroin regenerated from similar solutions had the same isoelectric points but different pH-mobility curves. Fibroin regenerated after dissolving in solutions of lithium bromide gave the same pH-mobility curve as untreated fibroin.

I. INTRODUCTION

ONE of the principal difficulties involved in defining many of the characteristics of silk results from the fact that the naturally-occurring fiber consists of at least two proteins, namely, silk fibroin and silk sericin; which have very different properties. Since the latter is generally removed from the fiber by empirical methods, the available data on many of the properties of the fibroin may be of questionable validity, especially since ordinary chemical methods are inadequate for determining the extent of removal of the sericin.

Sericin is a soluble protein which appears to form a coating on the surface of the fibroin. It has been shown by Abramson and others that a number of surfaces, when coated with any one of several proteins, assume electrophoretic properties similar to those of the adsorbed materials, and it was felt, therefore, that an electrophoretic technique could be employed to advantage in studies of silk. Such an approach can not only be used for studying the removal of sericin from fibroin but also the additional advantage of contributing information relative to the amphoteric properties of the constituents of the naturally-occurring fiber.

Electrophoretic techniques have been frequently used to investigate the properties of protein surfaces. Excellent discussions and reviews on the general subject have been presented by Abramson[1, 2] and by Moyer[3].

One characteristic constant of a protein which is determined by its electrokinetic behavior is the isoelectric point. As defined by Abramson[1] the isoelectric state of a surface of a particle is that electrical state in which the sum of the positive and negative charges at the surface over a time average is equal to zero. The isoelectric point then is defined as the reference concentration of hydrogen ion or some other ion (Th ++++, for example) at which this condition is found. In other words, although it has become customary to define the isoelectric point in terms of the pH scale, it must be defined in terms which include a complete description of the medium in which no migration takes place. In the electrophoretic technique, the isoelectric point is, therefore, the point at which the electric mobility is zero.

It has been assumed by some investigators that the isoelectric state of a substance depends only on the state of its dissociable acid and basic groups (its combination with hydrogen or hydroxyl ions). Actually, however, it depends not only on the combination with hydrogen or hydroxyl ions but also with other anions or cations which may be in the solution.† The point at which dissociable groups of the substance combine equally and only with hydrogen and hydroxyl ions is defined as the *isoionic point*[4]. It should be noted that this is identical with the isoelectric point only when the substance does not combine with ions other than hydrogen or hydroxyl. It follows then, that while it may be possible to determine the isoelectric point by several methods (e.g., by titration provided the substance binds *only* H+ or OH—), electrophoresis is the only method by which the isoelectric point is determined in every case.

The most satisfactory results with electrophoretic techniques have been obtained with soluble proteins in solution or adsorbed on inert surfaces such as quartz, glass, or paraffin oil. In many cases it has been found that a protein adsorbed on such a surface has electrokinetic properties which are very similar to those obtained for the same protein when studied in the dissolved state or in the form of relatively insoluble particles. It has also been noted by Abramson that the titration and mobility curves are congruent for a number of soluble proteins, and by making certain assumptions, he has predicted the following: in solutions of the same ionic strength, the electric mobility of the same protein at different hydrogen ion

*Research Associates for the Textile Foundation at the National Bureau of Standards.

†It should be noted that a surface may conceivably adsorb hydrogen or hydroxyl ions other than those bound by the acidic and basic groups.

activities should be directly proportional to the number of hydrogen or hydroxyl ions bound by each molecule. In the case of some of the soluble proteins, the isoelectric and isoionic points have been found to be approximately the same.

Considerably more difficulty, however, is encountered in interpreting the results of investigations dealing with insoluble materials, especially those which are more or less crystalline in nature[5]. For example, in some materials of this type, the isoelectric and isoionic points have been found to be far apart. As a result, no attempt is made, at this time, to relate the data obtained to the specific acidic and basic properties of silk. However, it was found that the electrophoretic technique provided an excellent tool for distinguishing protein surfaces and it was in this connection that it was used in the present investigation.

II. DESCRIPTION OF APPARATUS, METHODS AND MATERIALS

An Abramson horizontal micro-electrophoresis cell was employed in this investigation. The apparatus and methods were essentially the same as those described by Moyer[6]. The apparatus was checked from time to time by measuring the mobility of human erythrocytes in $M/15$ phosphate buffer at pH 7.4[7]. A 28x ocular and 40x water-immersion objective were used for measurements involving soluble proteins adsorbed on glass particles. Particles of ground silk were observed with a 20x ocular and 20x objective.

In most cases, the mobilities were measured by observing the velocity during migration of the particles at the 0.21 and 0.79 depth levels of the cell, where the effect of the electroosmotic flow of the liquid is eliminated[6]. When the mobilities were very low, the velocities of the particles were measured in successive layers from the top to the bottom of the cell, and the mobility was evaluated by graphical integration of the curve obtained by plotting velocity against depth[1].

The majority of measurements were made on samples of raw and degummed silk which were reduced to a suitable particle size by cutting in a small, laboratory Wiley mill until the particles passed through a 60-mesh screen. A suspension of the particles in water was made and allowed to settle. The supernatant liquid was recovered and found to contain particles approximately 1 to 5 microns in diameter.

The mobilities of dissolved silk or sericin were measured by adsorption of the protein on particles of Pyrex glass of 0.1 to 2 microns diameter. The particles were thoroughly cleaned by washing with cleaning solution, water, concentrated hydrochloric acid, water, 0.0001 N ammonium hydroxide, and then finally soaking for three days in distilled water, during which time the water was changed daily.

The mobilities of soluble materials were always measured in solutions containing a concentration of protein sufficient to insure complete coating of the glass particles. The required concentration was determined by measuring the mobility as a function of concentration of protein at constant pH, and determining the point beyond which further increase in protein concentration caused no further change in the mobility of the glass particles.

All mobility measurements were made in a room at approximately 25° C. All values were corrected to 25° C. by applying a factor of 2 per cent per degree[6].

pH values of the suspensions were measured with a MacInnes and Belcher type glass electrode and an electron ray meter. The pH values were referred to potassium acid phthalate (0.05 M) which was assigned a pH value of 4.01[8].

The silk used was the product of the silkworm *"Bombyx mori."*

III. EXPERIMENTAL

(1) Electrophoretic Properties of Raw Silk

Curve 1 in Fig. 1 shows the mobilities as a function of pH for three different samples of raw silk. The mobilities were measured after overnight immersion of the particles in hydrochloric acid-potassium chloride (pH range of 1.7 to 3.0) or acetic acid-sodium acetate (pH range of 3.0 to 6.5) solutions of ionic strength 0.02. Since sericin is relatively soluble it was expected that some of the material would dissolve in this time and then completely coat the particles of cut up silk. That curve 1 actually represents the mobility of sericin adsorbed on silk was demonstrated by the following experiments.

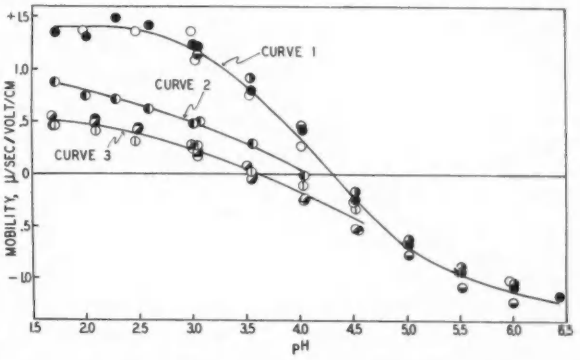


Fig. 1—A comparison of the pH-mobility curves for raw and degummed silks. Curve 1 represents the mobilities for 3 different samples of raw silk, ●, ◒ and ◑, and for sericin adsorbed on glass particles, ○. Curve 2 is that for silk degummed for 2 hours with soap. Curve 3 represents the results for 1, 2, and 3 cycles of degumming treatment as listed in the text.

A sample of sericin was obtained by boiling 10 g. of natural silk in two 150 ml. portions of water for 15 minutes each. One drop of a suspension of Pyrex particles was then added to each of a series of solutions of the same pH but containing varying amounts of sericin. The mobilities of the glass particles were measured after allowing 15 minutes for adsorption. The two curves, shown in Fig. 2,

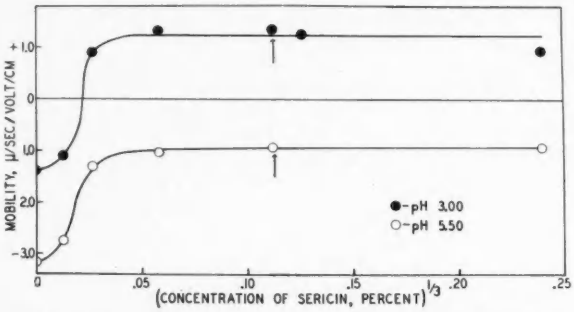


Fig. 2—Mobility as a function of concentration of sericin at pH 3.0 and pH 5.5, in 0.02 *M* ionic strength buffers.

were obtained by plotting mobility as a function of sericin concentration and indicate that complete coating of the glass particles by sericin occurs in solutions containing as little as 0.0001 per cent of sericin. The mobility of sericin adsorbed on glass was then measured as a function of pH. The solutions used contained approximately 0.001 per cent of the protein. The results as shown by the open circles in curve 1, Fig. 1, indicate that the pH-mobility curve for the adsorbed sericin is identical with that obtained for the sericin on the silk fibers. The data also indicate that the sericin is isoelectric at pH 4.3.

(2) Electrophoretic Properties of Degummed Silk

Soap Degumming. 50 g. of natural silk was boiled successively in four 2-liter portions of a 1-per cent solution of soap for a total time of 2 hours, then extracted with cold alcohol and ether and finally washed twice with water at 50° C. Curve 2 (Fig. 1) is the pH-mobility curve for the degummed sample. After the above degumming treatment, some of the fibers were shaken with a hydrochloric acid-potassium chloride solution (ionic strength 0.02) of pH 1.77 containing some glass particles. It was found that an amount of sericin sufficient to alter the mobility of the glass particles was still present.

In an attempt to remove all of the sericin from the fibers, 10 g. samples of the silk were subjected to successive cycles of the following treatments: a boil-off in 2-liter portions of a 1-per cent solution of soap for 3 successive one-half hour periods, a 5-minute boil in 2-liters of water, a 5-minute rinse in 2 liters of 0.1 *N* ammonium hydroxide, a 5-minute rinse in 2 liters of 0.1 *N* hydrochloric acid, a 1-day wash in running distilled water, a 4-hour extraction with cold alcohol, and finally 3 successive rinses in distilled water at 50° C.

Curve 3, Fig. 1, shows results for samples subjected to one, two, and three cycles of the above series of treatments. No measurable change was produced after the first treatment, which appears to indicate that the samples were completely degummed. Curve 3 therefore represents the pH-mobility curve for fibroin, and indicates that the material is isoelectric at pH 3.6 in 0.02 ionic strength acetate buffers.

Enzyme Degumming. A 10-g. sample of silk was treated with 1 liter of a solution containing 20 ml. of serizyme (papain) at 50° C. for a total of about 500 hours. The enzyme solution was changed three times during the first 100 hours of treatment. Removal of sericin as measured by loss in weight and nitrogen determination was rapid during the first 50 hours of treatment. The fibers continued to lose weight during the first 400 hours but appeared to reach a constant value after that time.

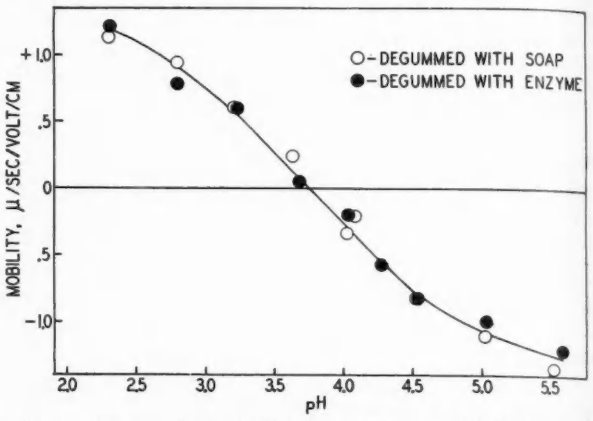


Fig. 3—A comparison of pH-mobility curves for silk degummed by soap and enzyme treatments.

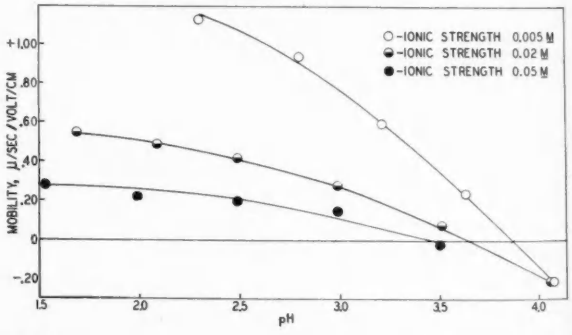
Fig. 3 shows the results of pH-mobility measurements on the sample in hydrochloric acid-potassium chloride and acetic acid-sodium acetate solutions (ionic strength 0.005).*

Similar measurements, made at the same ionic strength on a sample which had been completely degummed by the soap boil-off method, are included in the figure. The data obtained on the two samples are in good agreement and indicate the complete removal of the sericin.

(3) Effect of Variation of Ionic Strength

The curves in Fig. 4 represent data for soap-degummed fibroin in hydrochloric acid-potassium chloride buffers of 0.005, 0.02, and 0.05 ionic strength. The maximum shift in isoelectric point in these solutions is approximately 0.4 pH unit.

Fig. 4—Effect of variation of ionic strength on the pH-mobility curve of degummed silk.



*The ionic strength was decreased from 0.02 used previously to 0.005 in order to facilitate measurements by increasing the mobilities.

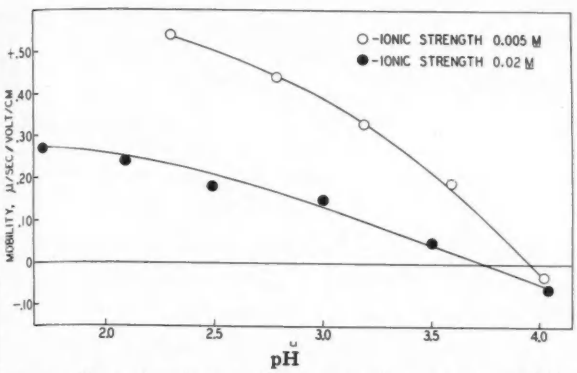


Fig. 5—Effect of variation of ionic strength on the pH-mobility curve of dissolved fibroin adsorbed on glass particles.

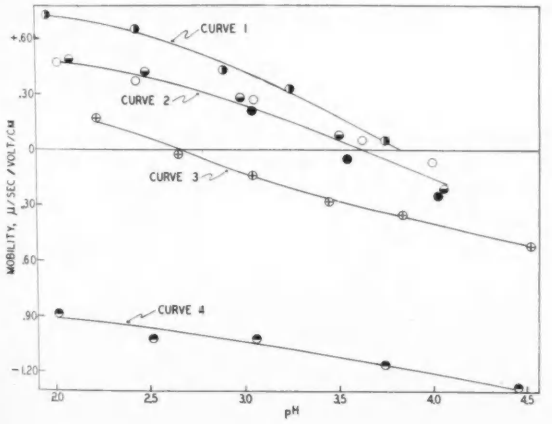
Fig. 5 represents similar curves at 0.005 and 0.02 ionic strength for dissolved fibroin coated on glass particles. The material was prepared as follows: 0.5 g. of degummed fibroin was heated in 5 ml. of a 50-per cent solution of lithium bromide (specific gravity 1.53) on the steam bath for 5 minutes. The solution was dialyzed (specific resistance approximately 30,000 ohms), coated on glass particles, and the mobilities were measured. The curves show that the same relation between mobility and ionic strength holds for the dissolved fibroin as for the solid material.

(4) Specific Ion Effects

The isoelectric points (3.5-3.9) obtained in the present investigation are higher than that (2.5) previously reported by Harris[9]. The differences appear to be too large to be accounted for by the differences in ionic strengths used in the two investigations. However, it was noted that hydrochloric acid-potassium acid phthalate buffers were used in the earlier investigations, which suggested that the differences might result from specific ion effects.

The effect of different ions in shifting the point of maximum flocculation and other protein characteristics has long been recognized[10, 11]. This is especially true for polyvalent ions[12]. Fig. 6 shows results of pH-mobility measurements in 6 different types of solutions, on fibroin degummed by the soap boil-off method. All of the buffers except the phthalate were of ionic strength 0.02. The phthalate solutions varied in ionic strength from 0.05 to 0.10.

Fig. 6—Effect of different ions on the electrophoretic mobility of degummed silk. Curve 1, oxalic acid-potassium hydroxide solutions. Curve 2, solutions of hydrochloric acid-potassium hydroxide, ◒; sulfuric acid-potassium hydroxide, ○; and acetic acid-sodium hydroxide, ●. Curve 3, Clark's phthalate buffers. Curve 4, picric acid-potassium hydroxide solutions.



Curve 2 represents the data obtained in the hydrochloric acid-potassium chloride, acetic acid-sodium acetate, and sulfuric acid-potassium sulfate solutions. In these systems, the samples were isoelectric at about pH 3.6, although there may have been slight divergences between the different valence types. The phthalate buffers (curve 3) caused a shift in the isoelectric point of approximately 1 pH unit to pH 2.6, in agreement with the data of Harris.* Oxalic acid causes a smaller shift in the opposite direction (curve 1). In the picrate solutions (curve 4), the sample was so electro-negative that it no longer exhibited an isoelectric point in the pH range used.

(5) Effect of State of Aggregation

Silk is readily dissolved by concentrated solutions of certain neutral salts[13, 14, 15]. With some salts, such as lithium bromide, solution is accomplished at room temperature.

A sample of degummed silk was dissolved by shaking with a 50-per cent solution of lithium bromide at room temperature for several hours and the solution dialyzed against running distilled water. After about 2 days, a precipitate was formed. Microscopic examination of the material showed it to be made up of well-defined fibers which were strongly birefringent.

When the fibroin was dissolved by heating in a lithium bromide solution on a steam bath, spontaneous formation of a fibrous material did not occur during subsequent dialysis. On addition of ether, a precipitate which appeared to be somewhat fibrous and of low-order birefrigence was obtained.

pH-mobility curves in solutions of 0.005 *M* ionic strength for both samples of regenerated fibroin as well as for the dissolved materials coated on glass particles are given in Fig. 7.

IV. DISCUSSION

A comparison of the curve for sericin (curve 1, Fig. 1) with that for fibroin (curve 3, Fig. 1) shows that the mobility of the former is much greater, which strongly suggests that sericin contains a much greater proportion of the reactive carboxyl and basic amino groups. This has recently been confirmed by chemical analyses[16]. The

*The results for phthalate solutions (Clark's buffers) are not directly comparable with those for the other buffer types because of the difference in ionic strengths. However, the data given above for fibroin in solutions of different ionic strengths indicate that only a minor portion of the shift is caused by this factor. This is confirmed by the fact that a five-fold decrease in the ionic strengths of Clark's buffers causes an increase of only about 0.3 pH unit in the isoelectric point of wool 16.

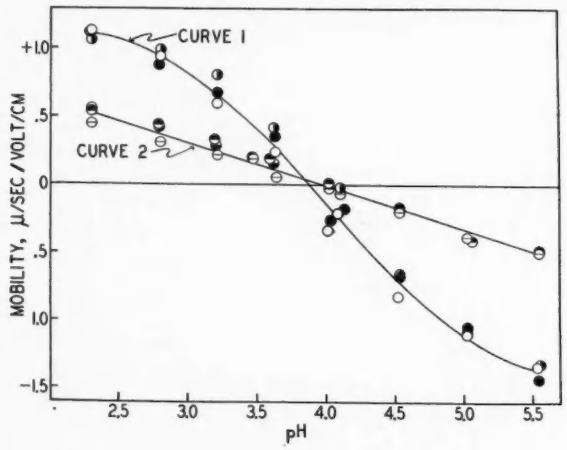


Fig. 7—Effect of state of aggregation on the electrophoretic mobility of fibroin. Curve 1 represents the mobilities of degummed fibroin, ○; fibroin regenerated after solution in hot lithium bromide, ◑; and fibroin regenerated after solution in lithium bromide at room temperature, ●. Curve 2 is for dissolved fibroin adsorbed on glass. The solutions were obtained by heating fibroin in solutions of lithium bromide for 5 minutes, ⊖, and for 2 hours, ⊖, and by solution of fibroin at room temperature, ⊖.

practical significance is at once obvious. Many of the problems related to silk and silk processing are in part, at least, concerned with the surface characteristics of the fiber. For example, the presence of a small amount of sericin may have a profound influence on the dyeing properties, and uneven distribution of the residual sericin would probably result in uneven dyeing of the fibers. It is not within the scope of the present investigation, however, to do more than point out some of the implications of these electrophoretic studies. The relationship of the difference in chemical properties between fibroin and sericin to the more practical aspects of silk chemistry is being studied separately[16].

The specific ion effects noted in Fig. 4 indicate that considerable care must be exercised in choosing buffer systems for protein investigations. These data also emphasize the necessity of including in the definition of the isoelectric point a description of the medium in which no migration takes place.

Sufficient data are not available for the elucidation of the nature of specific ion effects. In general, it appears that the greatest anomalies arise when large ions of complex structure such as phthalate or picrate are used. The results suggest a number of possible explanations. For example, the acid of the buffer solution might react with basic groups of the fibroin to form a slightly ionized compound; the anion might react with, or be adsorbed by the fiber in such a manner as to allow one of the acid groups of the adsorbed ion to be free; the strength of the acid or basic groups in the fiber might be altered by the proximity of the polar groups of the anion; or the adsorbed anion might provide charged centers which might even permit the adsorption of other ions.

It is well known that picric acid forms compounds with many proteins. Silk undoubtedly also forms picrates as evidenced by the color of the fibers. In the case of colorless ions such as phthalate ions, however, similar reactions are not at once obvious. The electrophoretic technique accordingly may often prove useful as a qualitative indication of such reactions.

Examination of the curves in Fig. 7 reveals a number of points of interest. The dissolved fibroin, adsorbed on glass particles (curve 2) exhibits lower mobilities than the untreated or regenerated fibroin (curve 1) throughout the pH range tested. The mobilities of the undissolved fibroin were roughly twice those of the dissolved material adsorbed either on glass or quartz particles. These data are in disagreement with earlier data by Harris[9] in which it appeared that the mobilities were the same. The present work, however, indicates that the solutions used previously were too concentrated and, as a result, the majority of particles appearing in the solution were those of regenerated fibroin. These, as shown (solid and half-solid circles, curve 1), give a pH-mobility curve which is identical with that of untreated fibroin (open circles, curve 1).

Although only one curve is drawn to represent the points for the solid fibroin and one for the points for the dissolved material, it appears that dissolving fibroin in hot solutions may have produced slight alterations in it. For example, in curve 2, the points for the material obtained by solution at room temperature are consistently below those obtained for material dissolved in the hot solutions. The differences, however, are too small to warrant any further conclusions at this time.

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Tentative Program for Nineteenth Annual Meeting Appears on Page P411

The Evaluation of

Finishing Treatments

Progress Report — April, 1939

A RANGE of fabrics from a heavy treated and untreated cotton material through velvet and Congo cloth to a thin cotton material and organdie and tracing cloth have been examined on the M. I. T. drape tester, the Gurley stiffness tester, and by the pear and heart hanging loops.

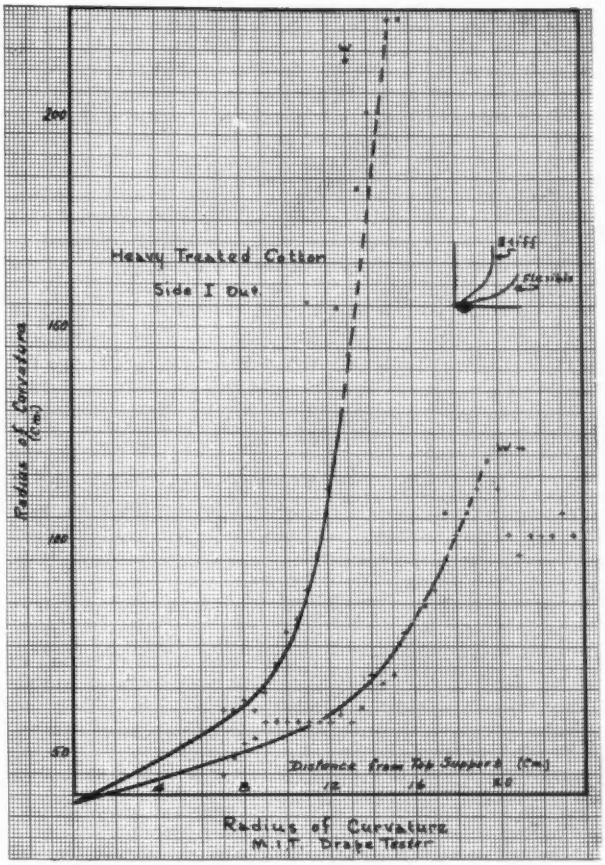
The work is not yet complete on all tests for all samples but typical curves from the drape meter tests are included herewith and in the following is a brief statement as to the significance of the tests thus far.

Reference to the first paper published in the AMERICAN DYESTUFF REPORTER and in Textile Research for April, 1939, will give the initial ideas in regard to the use of the M. I. T. drape tester. Two modifications of technique in connection with this instrument are being investigated and look very promising. One involves the measurement of the chord length between the edges of the vertically suspended fabric at intervals from the point of suspension down to the bottom edge. A plot of the results appears to give smooth curves which indicate degree of stiffness.

An attachment was also designed and built which allows determination of the radius of curvature of the distorted sample at any selected intervals for height as may be desired. These curves are not quite so smooth but indicate the same general trend as the first series and show differences in stiffness in the two directions of the fabric and between fabrics. In most cases there is also to be found a difference in stiffness between one side in the concave curvature as compared with the opposite side bent to the concave position.

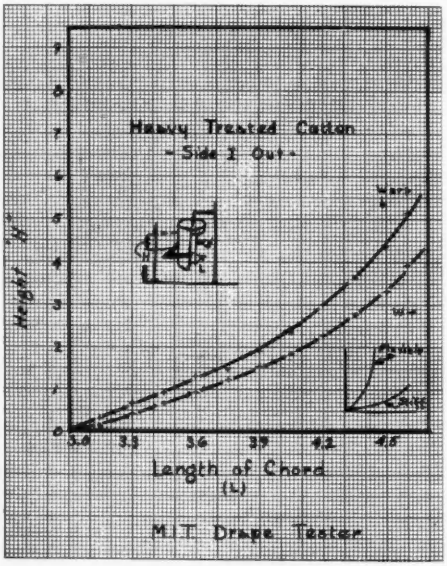
Work in the renovation of the laboratory has prevented use of a sufficient range of humidities to completely study the effects of humidity on stiffness but as soon as the laboratory is again in commission, the work will be continued with this idea in mind.

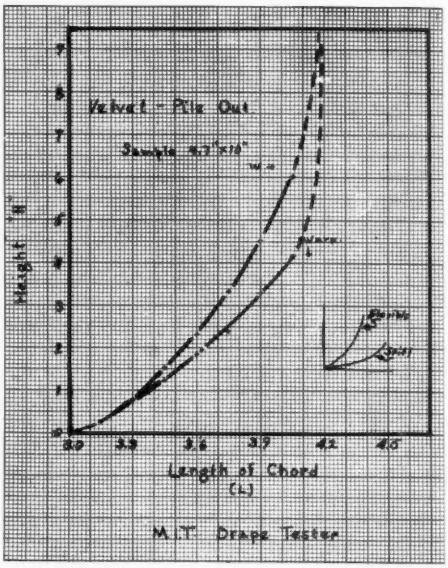
A resilience and thickness tester on the order of that used by Schiefer at the Bureau of Standards for determination of the thickness and resilience values to be used in converting the bending length determined from the hanging loop to modulus of rigidity and modulus of bending is under construction.

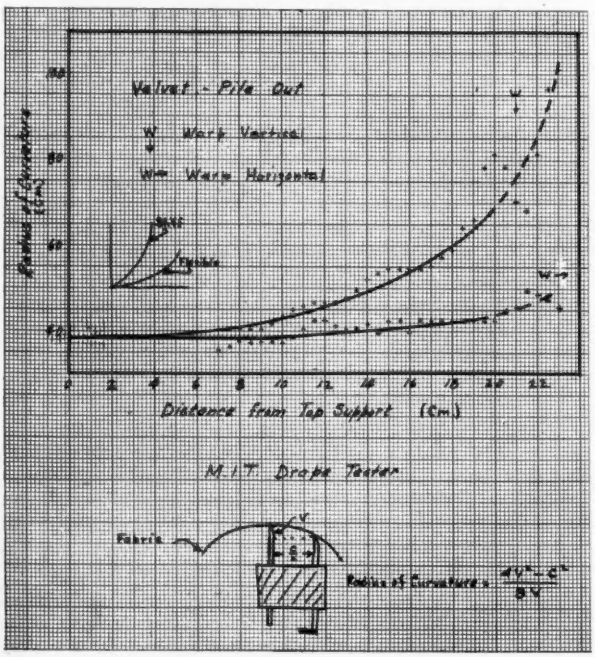


Work is also under way in the determination of the weight per unit area for these samples and the further determination of the relationship between bending length, modulus of rigidity, modulus of bending, radius of curvature, and chord length as measured by the M. I. T. drape tester. The relaxation of the hanging loop on standing and after known deformation is also to be investigated as is the relationship between the actual circumference of the loop and the bending length ratio.

Using the Spearman rating system as advocated by Binns it is believed that it will be possible to relate the agreement of rating of stiffness between a series of fabrics







by different but comparable methods of tests. It has been shown by this technique that the relationship is very poor between the tests which measure deformation and the tests which measure the deforming chords. This is undoubtedly to be expected because of the difference in the nature of the factors being measured and it is in line with our theoretical ideas upon the subject. When a sufficient amount of data is available to compare several methods of testing deforming force against each other and several methods of deformation against each other the Spearman ratio should be high in each case.

CORRECTION

Re: Printing Pastes

MR. HENRY KAUFMAN has kindly called attention to errors in an article[1] on Printing Pastes in the AMERICAN DYESTUFF REPORTER. The proportion giving the ratio of components in the system K_2CO_3-Na_2CO_3-H_2O is partially inverted and should read:

Mols K_2CO_3 : mols H_2O : : distance C to point : distance A to point.

This, of course, applies only to points on the line AC, similar proportions hold on the other sides of the triangle.

Due to arithmetical error the values shown on the curve for the saturation isotherm of this ternary system are incorrect. Retabulated values, together with the original weight percent data, are given herewith. It is to be noted that point to be stressed, namely the greater solubility of mixtures of Na_2CO_3 and K_2CO_3, is still valid.

Point on Curve	*Wt. % H_2O*	*Mol % H_2O*	*Wt. % Na_2CO_3*	*Mol % Na_2CO_3*	*Wt. % K_2CO_3*	*Mol % K_2CO_3*
a	47.4	87.5	0	0	52.6	12.5
b	47.1	87.0	3.0	0.9	49.9	12.0
	47.4	87.0	3.6	1.0	49.0	12.0
	48.2	87.5	3.6	1.1	48.2	11.4
	58.8	91.0	7.6	2.0	33.6	7.05
	63.6	92.0	19.0	4.6	17.4	3.3
	63.6	92.0	21.1	5.2	15.3	2.9
	63.6	92.0	22.5	5.5	13.9	2.6
c	63.6	92.0	19.2	4.7	17.2	3.2
	65.3	92.4	18.7	4.5	16.0	3.0
d	82.2	96.4	17.8	3.6	0	0

From data of Hill and Miller, Journal American Chemical Society, *49*, 669, (1927).

[1]American Dyestuff Reporter *28*, 282, 1939.

Am. Dyestuff Rept. 28

The Evaluation of Wetting Agents

JOSEPH W. CREELY and GEORGE LE COMPTE

THE most commonly accepted method for measuring the effectiveness of wetting agents is the Draves' wetting test[1] which "consists essentially of finding the concentration of wetting agent that is required to cause the sinking of a 5-gram skein of unboiled, grey, 2-ply cotton yarn in a standard period of time when the skein, carrying a hook of standard weight, is held beneath the surface of the wetting solution by a heavier weight called the anchor." By this method, the shorter the sinking time, the more effective is the wetting agent.

Some time ago a laboratory batch of an experimental wetting agent was tested and found to be a very effective material. The material was tested by the Draves' method using a yarn with a high twist that caused it to curl up when it was dropped into the solution to be tested. After these wetting tests had been run, the supply of this yarn was exhausted, and more yarn was ordered. The yarn received was soft and loose, had little twist, and possessed a good deal of "fur" or "whisker." When subsequent batches of the above mentioned experimental wetting agent were tested with the new yarn, they appeared to have practically no wetting power. A good deal of time was spent in making up new experimental batches, none of which appeared good. Finally, when the original batch of wetting agent that had appeared so promising was tested with the new yarn, it too appeared to be useless. This showed that the trouble lay not with the different batches of wetting agent but in trying to evaluate different batches of wetting agent using different yarns. A new lot of yarn was found to wet out well with the different batches and a good product was soon developed with little trouble.

From this experience it is apparent that the results obtained with the Draves' wetting method depend to some extent upon the yarn used. It must be emphasized that the Draves' method is intended to compare one product with another. Conclusions as to the effectiveness of a wetting agent should be based upon a comparison of the concentration required to cause sinking in a standard time with a given yarn for the wetting agent and for a standard product.

Some further work was carried out to demonstrate further the effect of different yarns upon wetting time. The results obtained follow.

TABLE 1
Draves' Wetting Test Method

Type of Yarn	*Product A* 0.1%	*Product B* 0.1%
Hard, high twist	63 sec.	34 sec.
Soft, low twist	44 sec.	31 sec.

On examining the results in Table 1, it will be observed that not only does the yarn used have a considerable effect on the wetting time obtained, but that the yarn exerts more effect upon one wetting agent than it does on the other. Thus, product A shows a wetting time approximately 50% greater using the hard yarn as compared to the wetting time using the soft yarn. A similar comparison on product B shows a corresponding increase of only 10% (approx.).

Some work was also tried with the canvas disc method[2], using two different samples of canvas. It was found that one sample of canvas was very resistant to wetting. The results indicated the necessity of using a specified grade of canvas, as first pointed out by Seyforth and Morgan[2].

It has been the experience of the authors that each technical application of wetting agents tends to be unique, and that the ordinary methods of evaluating wetting agents often do not correspond in results with actual performance of the products in plant usage. To give an example in which the ordinary Draves' wetting test or canvas disc methods do not correspond with actual working conditions, we can take the wetting out of scoured wool with carbonizing acid. In the Draves' method the skeins are wet out in a solution that generally must contain 0.1% or more of wetting agent to show fairly rapid wetting out and to give fairly reproducible results. In wetting out scoured wool, it has been found that the most economical method of employing the wetting agent consists in passing the wool through a solution containing from 0.002% to 0.01% wetting agent and 1.0% sulfuric acid, squeezing, and then feeding it into the carbonizing acid. An effective material when used at a concentration of 0.002% will cause a rapid sinking with some wools, while other materials with the same wool will not be effective even at a concentration of 0.05%.

For comparing the efficiencies of wetting agents for use in carbonizing, the authors believe that the best method is

as follows: Weigh 2.00 grams of the wool to be treated. Wet it out thoroughly in a convenient bulk of solution containing 1.0% sulfuric acid and 0.01% wetting agent, put through a wringer, then place the wool on the surface of the carbonizing liquor, and observe the time for the wool to sink completely below the surface. Depending upon the materials being tested, it may be necessary to use higher or lower concentrations of wetting agent. Results obtained with two wetting agents by the wool test just described and by the Draves' method follow. Both the wool tests and the Draves' tests were run in sulfuric acid solution.

TABLE 2

	Product C	*Product D*
Draves' Method	1.00%; 34 sec.	1.00%; 5 sec.
	0.50%: 111 sec.	0.50%; 10 sec.
	0.20%; >10 min.	0.20%; 29 sec.
Wool Test	0.01%; 6 sec.	0.01%; >5 min.

It will be observed that although product D is far superior by the Draves' wetting test, it is useless as a wetting agent in carbonizing liquor.

Another case in which it has been found that ordinary wetting tests fail to evaluate correctly lies in the use of wetting agents in Sanforizing. The authors believe that the test most commonly employed by companies using the Sanforizing process consists in stirring a piece of boiled off, bleached cotton fabric in a solution of the wetting agent in question, putting through a wringer and drying the cloth. The concentration of wetting agent to be used is based on cost considerations. A material costing 12c per pound is used in 0.04% concentration. A material of a different price is used at a concentration such that the cost remains constant.

A strip of the cloth that has been treated with wetting agent and dried is taken and a weight attached to one end. The other end of the strip is held and the strip is placed with the lower weighted end in the water. The rate at which the water rises in the cloth by capillary attraction is measured. With an efficient wetting agent the water should rise two inches in 300 seconds or less. Results obtained with two wetting agents by the Draves' method and by the Sanforizing test are as follows.

TABLE 3

	Product A; 0.05%.		*Product B; 0.02%*	
	Height Inches.	*Time Sec.*	*Height Inches.*	*Time Sec.*
Sanforizing Test.	1.0	50	1.0	260
	1.5	120	1.5	540
	2.0	235	2.0	>7800
	Product A; 0.25%		*Product B; 0.10%*	
Draves' Test	29 sec.		32 sec.	

In the Sanforizing tests the water rose uniformly and smoothly in the case of the cloth treated with product A. With product B wetting was very irregular, proceeding in small patches and finally seemed to stop entirely. The conclusion would be that product A is an acceptable material for Sanforizing while product B is relatively poor.

It will be observed that in both instances cited in which results as obtained by the Draves' method do not agree with actual practice, the fibers or fabrics in the actual processing are first wet out with mechanical aid in a dilute solution of the wetting agent and are then brought into contact with another solution in which effective wetting is desired. It is apparent that such processes offer a different problem from that in which dry fibers or fabrics are to be wet out. In the first case adsorption of the wetting agent would appear to be an important and perhaps necessary factor in contributing to rapid wetting in the succeeding bath. In the second case, that of dry fibers or fabrics, although adsorption of the wetting agent undoubtedly does take place to some extent, it does not seem that adsorption of the wetting agent would be such a necessary part of the wetting process as in the first case. It appears to the authors that in cases in which dry fibers or fabrics are to be wet out, the Draves' method should give results corresponding closely with practice. However, in processes such as the wetting of wool with carbonizing acid or in the Sanforizing process, where adsorption of the wetting agent in a preliminary bath appears to be of importance, it does not appear that the Draves' method would necessarily give results in agreement with practice. In such cases the authors believe the use of tests in which the adsorption factor is allowed to assume greater importance should give more reliable results.

The most general conclusion to be drawn is that each problem in wetting out tends to be unique and cannot in general be solved by one standard test applicable to all wetting problems. Tests on wetting agents to be used in a given process must be planned with the application in mind. The type of cloth or fiber, the pH of the solution, the concentration of the wetting agent, the temperature, the methods of manipulation, all should correspond as closely as possible with actual practice.

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Plan to Attend!
NINETEENTH
ANNUAL MEETING
Sept. 15 & 16 **Boston, Mass.**

A Consideration of the A.A.T.C. & C. Official and the Canvas Disc Methods for the

Evaluation of Wetting Agents*

CARL Z. DRAVES

As the use of surface active chemicals becomes more general and as more products are offered on the market, it becomes increasingly important that quick, simple and practical methods be available to select the product which is most suitable from the viewpoint of both effectiveness and money value. Because chemical analytical methods are not applicable, we must rely entirely upon physical methods.

Eight years ago at our annual meeting in Chattanooga I presented a method[1] for the evaluation of wetting agents which I had devised in the du Pont Laboratories two years previously. That method was adopted as a provisional method by the Research Committee of the Association and was presented as such in the 1931 and 1932 Year Books. After many laboratories had proved the usefulness of the method, it was made official in the 1933 Year Book and has been repeated without essential change since that time.

Last September, Seyferth and Morgan[2] published an article describing what they have called the Canvas Disc Method for testing wetting agents. A comparison was made between the Official Method (called by some the Draves Method) and the Canvas Disc Method for accuracy and time consumption. They concluded that the Canvas Disc Method is more suitable for dilute solutions and also more accurate under the same conditions. In more concentrated solutions the methods were found to give essentially the same results with the Official Method slightly more accurate. The present paper is presented in answer to the challenge offered by Seyferth and Morgan that the Official Method is not suitable for use in dilute solution.

Originally I had not intended to report at this meeting because I have not had time to carry on the amount of experimental work which the subject merits. However, when three speakers for our technical program withdrew at the last moment for very good reasons beyond their control, I decided to fill the breach myself, even though the experimental data which I have collected are still not so complete as I would like to have had them. However, before the results are published in the AMERICAN DYESTUFF REPORTER, I shall have had the opportunity of doing some further work. The paper as you will read it, therefore, will contain more data and will be more complete than this verbal report.

The Official Method, briefly, consists of measuring the time for a five-gram skein of unboiled, 2-ply cotton yarn to sink in 500 ml. of the wetting solution in a 500-ml. graduated cylinder when the skein is made heavier by means of a hook of standard weight and is held beneath the surface by a thread from a still heavier weight called an anchor. Values of sinking time for different concentrations are plotted on log-log coordinate paper, the points are joined and the concentration which causes sinking in 25 seconds can be read from the plot. The amount of wetting agent to cause wetting in 25 seconds may be called the "25-second wetting concentration." When this figure is determined for different agents, the analyst can then calculate the relative money values of the different products. A full exposition of the details of carrying out the Official Method, improved as a result of the work for this paper, appears in the next article (q.v.) in the form in which it will be published in the 1939 Year Book of the Association.

Your speaker believes he was the first to emphasize that solutions of different products which cause sinking by a standard method in the same standard time are equivalent in wetting power. There are still some people, however, who have the idea that a wetting time of 25 seconds, for a given concentration of a product, indicates twice the wetting power of another product which requires 50 seconds for the same concentration. This is far from the truth as you can appreciate if you study the plots of the usual data. Actually, for the average product, the wetting time is approximately doubled when the concentration is decreased 25 per cent.

Seyferth and Morgan (l.c.) claim for the Disc Method for testing wetting agents that it is quicker and more accurate, especially in dilute solution. The method, very briefly, consists of measuring the time required for a canvas disc 1 inch in diameter cut with a punch from a No. 6 Mount Vernon duck* to sink in a solution of the

*Presented at Annual Meeting, Atlanta, Ga., Dec. 2nd, 1938 and recently revised.

[1]Draves and Clarkson, American Dyestuff Reporter *20*, 201 (1931).

[2]American Dyestuff Reporter *27*, 535 (1938).

*No. 6 Mount Vernon duck can be purchased from Harrington, King & Co. of 79 Commercial St., Boston, Mass.

wetting agent when held below the surface about ½ inch by a good funnel.†

For reasons of simplicity, Seyferth and Morgan prefer to plot their data on regular coordinate paper. However, since the log-log plotting of data shows so much more clearly what is happening, it is the only type of plot which we shall consider here.

If we study the comparison of data presented by Seyferth and Morgan for the two testing methods, we find that in their examination of five products they used concentrations which caused sinking in less than the 25 seconds, recommended in the Official Method, for only two of the products. Because they obtained greater accuracy for low concentrations where the sinking time was more than 100 seconds for the Official Method, they concluded the Disc Method is generally more accurate. Furthermore, since the sinking times for their dilute solutions were far less when using the Disc Method, they have indicated a time saving of 64 per cent.

The fact is that the Official Method was originally designed to evaluate wetting agents at a concentration of 3 or 4 grams per liter because I was under the impression, ten years ago, that such concentrations would be employed in a mill. A 1.5 gram hook and a 25-second sinking time gave the necessary conditions. Now I know that lower concentrations are probably more common. To compare a method which is more accurate in dilute solution, however, with one designed for use in concentrated solution is obviously unfair.

But the Official Method as described in the last Year Book did indeed need revision for the comparison of the relative efficiencies of dilute solutions. The Disc Method seemed to be a step in the right direction but it really is still open to the same criticisms as the old Official Method. Seyferth and Morgan in their work even showed sinking times up to 1800 seconds. The present study, therefore, was undertaken to extend the usefulness of the principle of equivalent wetting power and yet to keep sinking times reasonable in length.

I began my work with a consideration of the technique of the Disc Method because I soon found that concordant results could not be obtained by that method without certain precautions. Since these precautions were not in the original paper, they will be presented in detail here. In a private letter of January 9th, Seyferth has given them his approval.

The No. 6 Mount Vernon Duck used in the Disc Method possesses far less buoyancy than cotton yarn. A 5-gram skein of 40/2 cotton yarn sank in plain water at 25° C. in 30 seconds when weighted with a 16-gram hook, whereas a 5-gram strip of duck required only a 1-gram hook to sink in 30 seconds.

The depth of immersion of the disc affected the time of sinking but little. For a half gram of wetting agent per liter I obtained an average sinking time of 154 seconds at the regular depth of ½ inch, whereas at a depth of 8½ inches the average time for four discs was 145 seconds.

The position of the disc, whether vertical or horizontal, likewise had little effect. The average sinking time for six discs was 184 seconds for the horizontal position and 177 seconds for the vertical position. One does not need to worry, therefore, about the exact position of the disc or its exact depth.

Preliminary experiments on the relation of size of disc to sinking time seemed to indicate that disc size was important. After more than 50 tests at different concentrations of wetting agent, however, it was concluded that a 1-inch disc sinks in the same time as a 1¼-inch which has approximately 50 per cent more area or weight. It was definitely found, however, that a disc 9/16 inch in diameter is not satisfactory because it offers relatively too great a length of fuzzy edge to which bubbles tend to adhere accidently. During this part of the work it was also found important in cutting the discs to use a sharp punch against the end of a hardwood block.

The most important precaution to be observed for the disc method is to avoid adventitious bubbles of air which may adhere to the outside of the disc. When the wetting solution is poured from the volumetric flask into the beaker, the disc must not be entered until all bubbles within the solution have risen to the top and until the foam on the surface has either subsided or has been removed. A solution of 5 grams of Tergitol Penetrant No. 7 per liter gave instant wetting when the test was properly conducted, whereas a little surface foam caused the average time for several discs to become 5.0 seconds. At a lesser concentration the average sinking time was 3.9 seconds when properly conducted and 26 seconds when there were bubbles in the solution and a little foam on the surface. In another instance a very thin layer of surface foam caused the average time to increase from 15.7 seconds to 33 seconds. Seyferth and Morgan apparently also occasionally obtained abnormally long sinking times from adventitious bubbles.

The effect of bubbles and surface foam on the sinking times of skeins was also examined. It was found that a slight amount of foam or a few bubbles have little effect with the 1.5-gram hook for sinking times of 20 to 40 seconds; but for rather concentrated solutions the effect may be very marked. For example, a 5-gram per liter solution of Alkanol W X gave an average normal sinking time of 7.4 seconds for a 1.5-gram hook. When a foam was stirred up on top of the solution in the cylinder before each test, the average time became 240 seconds. On very dilute solutions, surface foam subsides very quickly; but even then one should wait until bubbles inside the solution can rise to the surface, just as for the Disc

†Soft glass Gooch filter tubes No. 7877 with inside diameter at top of 37 mm., from the Will Corp., Rochester, N. Y.

Method. When a 3-gram hook is employed, bubbles and foam have little, if any, effect. A certain concentrated solution of a wetting agent gave a normal average sinking time of 4.85 seconds or a 3-gram hook. The average sinking time in the presence of bubbles and foam was 4.6 seconds, or practically the same.

In using the skein method, some laboratories very occasionally have had difficulty with twisting skeins catching on the sides of the cylinder. In my own experience this happens rarely when testing wetting agents with skeins of 2-ply cotton yarn of balanced construction. On the other hand, in testing the wettability of single jute yarn the tendency of the skeins to twist and catch on the sides of the container is so great that a larger cylinder must be employed. In any event, it is advantageous in testing wetting agents to draw the skein through the fingers in order to straighten it out somewhat before it is entered into the solution. In previous directions it was suggested that grease from the fingers must not get onto the skeins used for testing. Further experience, however, indicates that the wettability of unboiled cotton is unaffected in this manner.

One would expect that the absolute moisture content of the cotton yarn used for testing would have an appreciable effect on sinking time; but such was not the case. Several skeins stored in a condition of low humidity (20 to 30 per cent R.H.) gave average sinking times of 4.15 and 13.8 seconds in two different concentrations of Alkanol W X. Similar skeins stored at 65 per cent relative humidity (in a standard testing room) gave average sinking times of 3.5 and 14.40 seconds, respectively, or not significantly different.

On the other hand, driving all the moisture from cotton, surprising as it may seem, caused it to wet a little more readily. For example, 4 skeins with a 3-gram hook gave an average sinking time of 20.2 seconds in a concentration of 2.5 grams per liter of Deceresol OT. Four other skeins were dried for 25 minutes in a strong draft of air at 120° C. and then cooled in a desiccator to lose 5.0 per cent of moisture. They gave an average sinking time of 10.7 seconds. On another day 10 skeins gave an average sinking time of 49.1 seconds in a certain concentration of Deceresol OT; whereas, 7 skeins dried at 110° C. for 20 minutes to lose 4.2 per cent of moisture gave an average sinking time of 45.1 seconds. On the other hand, a skein held in plain water for 20 seconds and then used for the test took 114 seconds to sink in the same concentration of Deceresol OT. A skein kept for 2 minutes in water at 55° C. and then used for the same test required 211 seconds for sinking. Four skeins used over water in a closed desiccator so as to gain 4.2 per cent more moisture gave an average sinking time of 54 seconds against the normal of 49.1 seconds. It would seem, from the meager data cited, that unboiled cotton varies but little in its tendency to wet when stored within the ordinary limits of relative humidity.

The construction of the cotton yarn or fabric has a very marked effect on the readiness with which the cotton material loses enough air when under water to sink. The duck used in the Disc Method sinks as readily when not carrying any hook as cotton yarn does when it carries a hook weighing 30 to 60 pr cent of its own weight. Seyferth says that the lighter grades of duck sink more readily than the No. 6. In the case of yarn, a 40/2 yarn with a singles twist of 15.3 turns per inch and a ply twist of 13.6 turns per inch gave a 25-second sinking concentration of 1.96 grams per liter with a 3-gram hook. A 30/2 yarn with a harder twist of 19.3 in the single and 20.5 in the ply gave practically the same 25 second sinking concentration, or 1.9 grams per liter, but with a 1.5-gram hook. The Disc Method applied to the same product gave a 25-second sinking concentration of 2.23 grams per liter. In other words, if Seyferth and Morgan had happened to use cotton yarn similar to the latter described above, they would have found that the Official Method with a 1.5-gram hook would have been *more* applicable to the examination of dilute solutions than the Disc Method!

It seems probable to me that the construction of the yarn for test has far more influence on the readiness with which sinking takes place than the individuality of the original lot of cotton fibers. This is a question which future work should settle.

A minor detail of technique is that of cutting the skein at the end opposite that which carries the hook. It seems really to make little difference although the bubbles appear to escape with greater facility from a cut skein. Six skeins cut at the top gave an average sinking time of 50 seconds when carrying a 3-gram hook in 2.5 grams of Deceresol OT per liter. Six uncut skeins under the same conditions gave an average sinking time of 47 seconds. When repeated at a concentration of 5.0 grams of wetting agent per liter, the cut skeins gave an average sinking time of 11.5 seconds and the uncut 11.6 seconds.

An interesting variation of the sinking test is employed in the Ciba Laboratory. In place of a skein they use 1 gram of 1¼-inch cotton tape. A piece of tape just 5 inches long is said to be sufficiently close in weight. A 0.3-gram hook tied to a 40-gram anchor gives reasonable sinking times. The other details of technique are the same as for the Official Method.

In Table I are presented average sinking times for canvas discs in varying concentrations of Product A at 25° C. (77° F.), conducted in the mixing beaker preliminary to the pouring of the solutions into the cylinders for the skein sinking tests. The average sinking times for skeins of 40/2 cotton yarn in these same solutions, determined according to the revised Official Method (see following article) for hooks of different weights, likewise appear in Table I. In the column following each average

TABLE I
Sinking Times for Product A at 25° C.—Seconds

Concen. g. per l.	Canvas Disc Av. T	Canvas Disc No. Tests	Canvas Disc Av. Dev. %	1.5-gram Hook Av. T	1.5-gram Hook No. Tests	1.5-gram Hook Av. Dev. %	3-gram Hook Av. T	3-gram Hook No. Tests	3-gram Hook Av. Dev. %	6-gram Hook Av. T	6-gram Hook No. Tests	6-gram Hook Av. Dev. %
0.5	808	4	20.1							139	6	21.6
.7										52.7	8	12.2
1.0	223	4	2.6	660	1		120	6	25.6	22.4	4	6.1
1.2										13.7	5	13.0
1.5	68.3	12	19.4	189	8	23.5	47.0	15	7.2	8.8	14	8.6
2.0	33.8	13	18.4	53.6	8	16.0	24.0	4	2.4	4.4	4	7.4
2.5	18.3	25	16.6	27.2	8	10.3	15.4	5	3.3	3.7	11	8.5
3.0	10.5	8	4.8	19.3	5	2.5	8.7	4	8.0			
3.5	8.0	9	8.1	14.3	8	3.5	7.0	4	1.4	2.3	8	6.0
5.0	3.9	25	11.6	7.5	7	11.2	3.8	6	12.7	2.1	4	4.8
7.5	2.1	5	11.4				2.2	4	0.0	0.0	4	
10.0	1.5	8	30.0	2.2	4	0.0	0.0	4				
11.0	.6	7	81.0	1.5	4	65.0						
15.0	0.0	4		0.0	4							

TABLE II
25-Second Sinking Concentrations—Grams per Liter Parts Equal to 100 of Product A (Bold Face Type)

Product	Canvas Disc	Weight of Hook (Grams) 1.5	2.25	3.0	4.5	6.0
A	2.23	2.57	2.18	1.96	1.41	0.95
	100	**100**	**100**	**100**	**100**	**100**
B	1.57	2.75	1.91	1.55	0.92	0.58
	70	**107**	**87**	**79**	**65**	**61**
C	1.01	1.2		0.87		.40
	45	**46**		**44**		**42**
D	7.2			10.0		2.12
	324			**510**		**224**
E	1.68	2.67		1.67		0.62
	75	**102**		**85**		**65**
F	6.8	37.2		5.3		1.31
	305	**1450**		**271**		**138**

sinking time, T in seconds, is given the number of tests used in arriving at the average; and following that again, in each respective next column, is the average deviation of sinking time from the average sinking time for a given concentration.

The data of Table I have been visualized in Figure 3 of the Official Method, except for the data for the Canvas Disc Method. The curve for the Canvas Disc Method would lie barely to the right and nearly parallel to that for the 3-gram hook.

In Table II are presented 25-second sinking concentrations in grams per liter of 6 different products for the Canvas Disc Method and for 3 and 5 weights of hooks for the skein method. These values have been obtained by interpolation from average sinking times straddling 25 seconds as explained in the Official Method and as illustrated by the upper part of Figure 4.

Under each 25-second sinking concentration in Table II appears a figure in bold face type which represents the number of parts of a product equal, at the concentration in question, to 100 parts of Product A at the concentration which causes sinking in 25 seconds under the same conditions.

From the data of Table I, as well as from the average deviations in the values used in Table II, it may be concluded that the Official Method is more accurate in arriving at 25-second sinking concentrations than the Canvas Disc Method. Furthermore, the best accuracy, in general, in the determination of sinking times occurs near 25 seconds.

The most striking conclusion to be drawn from this whole work is the one concerning equivalent values in Table II. Because different products do not behave the same upon dilution with respect to wetting, the concentration must be stated in speaking of the equivalence of two products. For example, Product B is relatively better in dilute solution than Product A. At 2.42 grams per liter, 100 parts of B are equal to 100 parts of A. At 0.58 grams per liter of B, it requires only 61 parts of B to be equivalent to 100 parts of A (see lower part of Figure 4 under Official Method).

A derived value of the data of Table II is the use of such information for the identification of wetting agents. It is obvious that products such as, for example, Products A and C, can be chemically similar only if the curves in the lower part of Figure 4 are equidistant apart horizontally, that is, if 25-second sinking concentrations bear the same relation to each other for the 1.5-, the 3-, and the 6-gram hooks.

I suggested at Atlanta that if there was demand, the Canvas Disc Method might be adopted as a tentative method for the Association. Correspondence on that subject is invited. A great need with respect to the Official Method is agreement among various laboratories on the use of cotton yarn of exactly the same construction to see if we can obtain the same 25-second wetting concentrations for various products.

Evaluation of Wetting Agents

Official Method*

CARL Z. DRAVES

THE method of testing wetting agents described here consists essentially of finding the concentration of wetting agent that is required to cause the sinking of a 5-gram skein of unboiled, grey, 2-ply cotton yarn in a standard period of time when the skein, carrying a hook of standard weight, is held beneath the surface of the wetting solution by a heavier weight called the anchor. The value of the concentration to cause sinking in the standard time is obtained by interpolation from a curve plotted from average values of sinking times determined with known concentrations of wetting agent.

The hook of standard weight and the attached anchor are prepared as follows: A piece of No. 10 B&S gauge copper wire about 2.53 inches long is bent into the form of a hook as illustrated by "A" in Figure 1 and then the weight of the bent hook is adjusted to exactly 3.000 grams. Nickel and stainless steel wire are even more suitable than copper for this purpose because they are harder, stiffer and more corrosion resisting. The anchor, "C," is a flat, cylindrical, lead slug weighing 40 grams and having a diameter of 1 inch (25 mm.) and a thickness of about 11/64 inch (4.43 mm.). In the center of the anchor is soldered a loop of wire to serve as a small ring, or eye, for attaching the anchor to the hook with a fine linen thread, "B," at a distance apart of ¾ inch (19 mm.). If many products are to be tested, prepare two hooks and anchors.

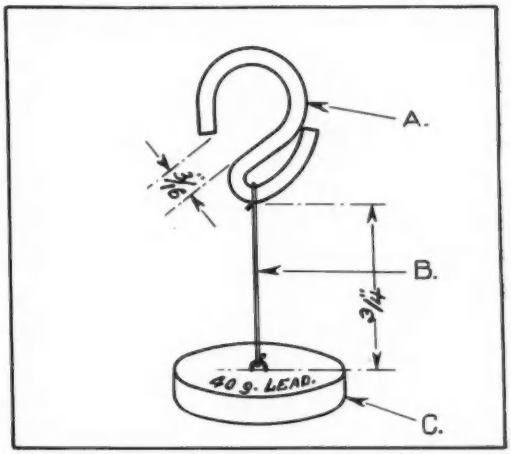

Figure 1.

For the preparation of the final solutions of the wetting agent for test it is convenient to take aliquot portions with conventional standard bulb pipets from a stock solution containing 50 grams of wetting agent per liter of solution. If the wetting agent is not very soluble it may be necessary to start with a weaker stock solution, or even to weigh the required amount directly. Aliquot portions of 5, 7, 10, 15, 25, 35, 50, 75 and 100 ml. of a 50 grams per liter stock solution give final concentrations of 0.25, 0.35, 0.50, 0.75, 1.25, 1.75, 2.50, 3.75 and 5.00 grams of wetting agent per liter, respectively, when diluted to one liter. This range of concentrations gives points at approximately equal close intervals on the logarithmic plot which will be explained farther on, and every value in the range can be obtained with either one or two standard bulb pipets.

The quality of the water used in the testing of wetting agents must be given careful consideration. The stock solution is best prepared with distilled water in which most wetting agents will dissolve readily without heat. When it is not known under what conditions the wetting agent is to be employed, distilled water may likewise be used for final dilution. On the other hand, for the simulation of mill practice, the final solutions for test—and even the first stock solution—should be made up with water from the mill and with any ingredients which are necessary to duplicate exactly the chemical composition of the solutions as they will be used in practice. If this is done, the pH will take care of itself automatically, although the careful chemist will want to check the acidity or alkalinity of the final test solutions either colorimetrically or electrically.

George Thomas has recommended for the purpose of uniformity that a standard concentration of acid and a standard concentration of alkali be employed for the general comparison of different products in other than neutral solution. To obtain a standard acidity he prefers 1 gram of sulfuric acid in 100 ml. of final test solution and to obtain a standard alkalinity, 1 gram of soda ash in 100 ml. of final test solution.

The diluted solution for test is poured from the liter volumetric flask into a 1.5-liter beaker to ensure mixing. The solution in the beaker is then divided equally between 2 500-ml. graduated cylinders. If the more dilute solutions are tested first, the mixing beaker and cylinders need not be rinsed out and dried each time. The operator must

*This method is not suitable for use in mercerizing liquors. For a discussion of this method see the preceding article.

wait after the cylinders have been filled until all bubbles *below* the surface of the solution have risen to the top before the sinking tests are made. He may advantageously prepare solutions for 6 more cylinders while he is waiting for the bubbles to rise. Although foam on the surface of the solution has less effect on the sinking times of a 3-gram hook than on the sinking times of a 1.5-gram hook, the careful operator will remove the foam with a 100-ml. bulb pipet.

Since temperature often markedly affects wetting, standard temperatures of 77° F. (25° C.), 122° F. (50° C.), 158° F. (70° C.), and 194° F. (90° C.) have been chosen for testing so as to include the complete, commercially useful, range. It is most convenient to attain a temperature of 77° F. merely by using water which has been brought to the correct temperature in a large pail. For tests at higher temperatures, heat the diluted solution for test in the mixing beaker to a temperature somewhat above that required, pour the solution into the cylinder which has been previously warmed with hot water on the outside and then allow it to cool back to the testing temperature.

Yarn for wetting tests must be unboiled, 2-ply, cotton yarn of the kind that is suitable for dye-testing. Since there is no consensus with respect to the size and construction of yarn for dye-testing, the committee is not ready to set definite specifications. It will be found that 40/2 yarn with a twist in the single of 20 turns per inch and a balanced ply twist (most laboratories do not use a fully balanced yarn) will be satisfactory. In general, the harder the twist, the faster a yarn wets.

For a determination, a 5.00-gram (77± 1-grain) skein of yarn is folded enough times to form a loop 18 inches around. A 36-inch skein is most convenient and can be formed into an 18-inch loop with only 2 folds; a 54-inch skein requires 3 folds; a 72-inch skein, 4 folds; and a 90-inch skein requires 5 folds. The hook with its anchor is fastened at one end of the folded skein and the skein is cut through with shears at the opposite end. The cut skein is drawn through the fingers when testing wetting agents in order to make it more compact. Any threads which have been tied around the skein to correct its weight are folded into the skein near the hook. The skein is held in one hand with the anchor dangling into the wetting solution contained in the 500-ml. graduated cylinder. A stop watch held in the other hand is started just as the skein is released into the solution and it is stopped when the buoyant skein definitely starts to sink to the bottom of the cylinder. The skein before sinking must be entirely covered with solution and yet it must possess enough buoyancy from the air within the yarn to keep the linen thread taut between the anchor and the hook (see Fig. 2). The average of at least four determinations of sinking time should be obtained for each concentration of wetting agent. An average deviation of 10 or 12 per cent in sinking time may be expected.

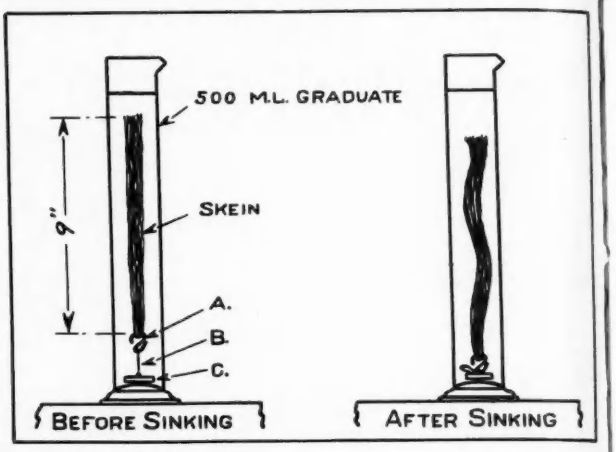

Figure 2.

The method of handling the data obtained by the technique described above is very important. The most useful plot where a complete curve is desired is one made on 2 by 2-cycle logarithmic paper No. 358-110L manufactured by the Keuffel and Esser Co. of New York. Values of concentrations of wetting agent are shown on the horizontal scale, or X-axis, the value on the extreme left being 0.1 gram and the value on the extreme right 10 grams per liter. The abscissa, or distance along the X-axis, therefore, really represents the logarithm of the concentration of wetting agent. But since the paper is printed with a scale like that of a slide rule, the looking up of logarithms is obviated. In like manner, the distance along the vertical, or Y-axis, represents the logarithm of the sinking time in seconds. A smooth curve is drawn through the points. For most products this curve will be a straight line. (See Fig. 3.)

Since solutions which cause sinking of skeins in equal times under similar conditions for the same lot of cotton yarn with the same weight of hook must be equivalent in wetting ability because they do the same thing, equivalent quantities of wetting agents are readily obtained by reading from the curves the concentrations which cause sinking in the same standard time of twenty-five seconds. For a comparison of the relative cost of products for actual use, both the cost of the wetting agent per pound and its effectiveness must be taken into consideration as in the following formula:

Cost per gallon of final processing solution for wetting= 0.00835
× (Cost of product per lb.)
× (Concn. in grams per liter for wetting in standard time.)

In the use of these values, on the other hand, it must be emphasized that they are applicable in comparing one product with another only when skeins from the same lot of cotton yarn have been used in testing both products.

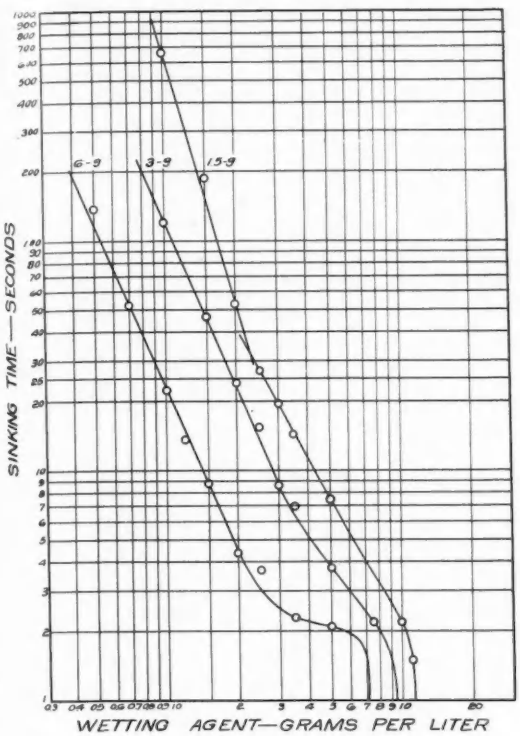

FIGURE 3

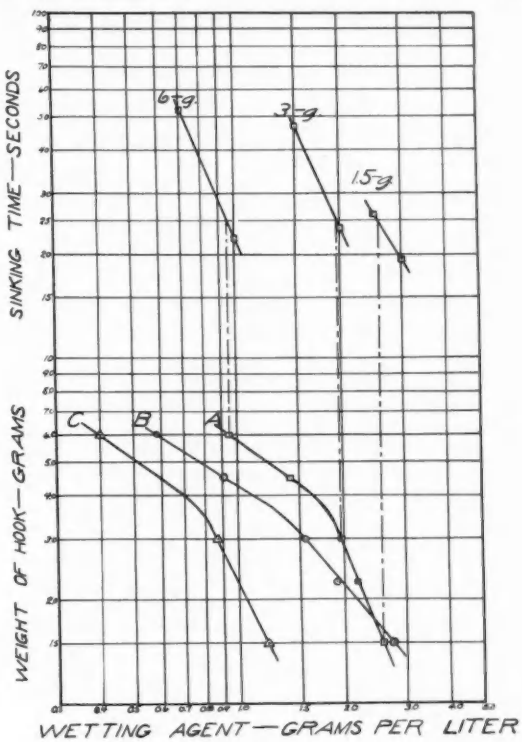

FIGURE 4

Different lots of cotton yarn, even when they have the same construction, do not necessarily possess the same wetting characteristics nor will they give the same standard sinking concentrations for a 3-gram hook.

As a result of experiments which are described in another place, it has been found that a 3-gram hook is more generally applicable in the testing of wetting agents where a single comparison is desired than the previously specified 1.5-gram hook. Sinking times with the heavier hook are less subject to error from bubbles and foam. Furthermore, the heavier hook gives values at lower concentrations which correspond more nearly to those used in practice.

The same experiments have shown clearly, however, that a comparison of products at one concentration is not sufficiently informative because some products are relatively less efficient at low concentrations than other products. For a complete picture of the behavior of a wetting agent, therefore, the concentrations to cause sinking in 25 seconds must be determined with a 1.500-gram, with a 3.000-gram and with a 6.000-gram hook. Competitive products of the same chemical type show the same strength relation to each other at different concentrations, that is, with the three different hooks, but products of a different chemical nature behave differently with dilution as illustrated in Figure 4.

For the determination of 25-second sinking concentrations it is not essential to run complete curves with one hook. To abbreviate the work, run single skeins at increasing concentrations with the 6-gram hook using a single bulb pipet until a time not far from 25 seconds has been obtained and then determine an accurate, average, sinking time for that concentration with at least 4 skeins. Using two bulb pipets to obtain a concentration differing only slightly from the last, determine another average value of sinking time such that the two average times bracket 25 seconds (as for example, 10 ml. and 12 ml.; or 10 ml. and 7 ml.). Plot the values as in the upper part of Figure 4, connect with a straight line and read off the concentration corresponding to 25 seconds. Repeat the procedure in like manner for the 3-gram and 1.5-gram hooks, remembering that the 3-gram hook will give a 25-second sinking concentration which is 2 to 5 times as great as the 6-gram and the 1.5-gram hook 1.5 to 2 times the concentration for the 3-gram hook. A full day's work will be required for the complete comparison of two products at one temperature and in one kind of solution.

Plot the 25-second sinking concentrations as abscissa on log-log paper against the weight of the hook as ordinate. Join the values for the 1.5- and 3-gram hooks with a straight line and draw a smoath curve to the value for the 6-gram hook as illustrated by curves A, B and C in Figure 4. The concentration of a product for test which is equivalent in wetting power to a certain concentration of standard may be read directly from the two curves. When the horizontal distance between two curves (as ap-

proximately illustrated by A and C in Fig. 4) is constant, the ratio of effective wetting strengths of the two products is the same at different concentrations, when the horizontal distance varies, the two products vary in strength with respect to each other at different concentrations as illustrated by A and B in Fig. 4.

DETERMINATION OF THE WETTABILITY OF YARNS AND THREADS

The general procedure outlined above for the evaluation of wetting agents can also be employed for measuring the readiness with which yarns and threads of cellulosic fibers wet in water. At least four skeins of yarn or thread are used for the determination of the average sinking time in pure water at 77° F. (25° C.). For goods that wet readily, such as kier boiled cotton, boiled linen, or ordinary jute, use a 0.500-gram hook for a 5-gram skein. The small hook must be used to overcome the buoyant effect of adventitious bubbles which tend to adhere to the yarn and to cause erratic results. If the sinking times obtained are over 60 seconds, it is advantageous to use a heavier hook weighing 1.500, 3.000, or 6.000 grams.

If even a 6-gram hook does not give sinking times of less than 60 seconds, a certain fixed concentration of wetting agent, such as 0.1 gram per liter, may be employed. In this way, even water repellent yarns and threads can be compared. It is obvious that in comparing two textile products, the same weight of hook and the same type of solution must be employed for both. If the skein being tested twists so badly as to catch on the side of the 500-ml. cylinder, a 1-liter cylinder may well be employed.

ONE HUNDRED AND SIXTEENTH MEETING OF THE RESEARCH COMMITTEE

THE 116th meeting of the Research Committee followed the Council meeting in New York on Friday afternoon, June 16, 1939. Present were Chairman Louis A. Olney presiding, K. H. Barnard, G. L. Baxter, J. R. Bonnar, W. H. Cady, Alban Eavenson, J. F. X. Harold, H. F. Herrmann, G. A. Moran, R. W. Philip, R. E. Rose, Charles A. Seibert, W. M. Scott, H. W. Stiegler, P. J. Wood, L. S. Zisman, and H. C. Chapin, Secretary.

There was extended discussion of how best to make test methods of the Association known and used, through trade associations, consumers' groups, etc. It was suggested that notes of general news value would be welcomed by newspapers and trade journals, and that news of Sectional meetings might be sent to local newspapers by the Secretaries of the Sections. It was suggested that consumers' organizations might be interested in the procedures by which tests are developed and adopted. Interest was reported in accounts of Council and Research Committee meetings presented to local Sections by their representatives. The formulation of definite plans for publicity was assigned to the Committee on Coordination of Standards.

The Fastness Tests for Dyed or Printed Cotton published in the June 12 REPORTER were modified slightly. The ratio of liquid to sample was fixed at 100 cc. per 2 grams. The balls for the Launder-Ometer were specified simply as "approved rubber balls." In pressing with flatiron it was specified that the white cloth be placed beneath the colored.

Mr. Barnard reported that satisfactory crease resistance tests had been developed for the Association at the Massachusetts Institute of Technology, and were being correlated with other existing tests. A letter was received from Mr. Hugh Christison regarding perspiration tests.

Need of work along new lines was debated, such as resistance to hot pressing, dry cleaning and fire; discoloration in storage; effect of gases on dyed acetate; and abrasion. In connection with hot pressing, Mr. Bonnar said that dye sublimation should be considered. Dr. Harold suggested that we obtain and publish a tabulation of the sources of dye intermediates. The Chairman suggested that we prepare specifications covering a standard soiled fabric for washing tests.

Respectfully submitted,

HAROLD C. CHAPIN, *Secretary.*

ONE HUNDRED AND TWENTY-THIRD COUNCIL MEETING

THE Council held its 123rd meeting at the Chemists' Club in New York on Friday morning, June 16, 1939. Present were President Alban Eavenson, presiding; Louis A. Olney, Chairman of the Research Committee; William H. Cady, Robert E. Rose and P. J. Wood, Past Presidents; Kenneth H. Barnard and Walter M. Scott representing Northern New England; George L. Baxter, Henry F. Herrmann and Harold W. Stiegler representing New York; Charles A. Seibert representing Philadelphia; Robert W. Philip, Chairman of the Southeastern Section, and W. H. Zillessen, Chairman of the Boston General Meeting Committee; and Harold C. Chapin, Secretary. The Secretary's report of the 122nd Council meeting and balance sheet of June 13, and the Treasurer's report of June 14, were accepted.

Reports from Section Treasurers to date were accepted. H. C. Chapin, H. F. Herrmann and W. R. Moorhouse were appointed a committee to pass on future reports before their submission to the Council, and to draw up a suitable form for the convenience of Section Treasurers. Appropriations were made for the publication of the Rayon Crepe Research Report in book form, and for the maintenance of the Secretary's office.

The Aridye Corporation was elected to Corporate Membership. Each of the following was elected to the class of membership specified, as of thirty days from publication of application, provided no objection be received meanwhile by the Secretary.

SECRETARY'S BALANCE SHEET

June 13, 1939

	Applications	*Dues, Regular and Reinstate.*	*Dues, Corporate and Sustain.*	*Miscellaneous*	*Bank Charges*	*Totals*
Received by Secretary, Nov. 1, 1938, to April 18, 1939	$747.50	$9,863.36	$2,355.00	$1,344.15	—4.17	$14,305.84
Received by Secretary, April 18 to June 13, 1939	185.00	220.00	375.00	103.05*	— .57	882.48
Total received	932.50	10,083.36	2,730.00	1,447.20	—4.74	15,188.32
Transmitted to Treasurer	835.00	10,018.36	2,730.00	1,367.50		14,950.86
Leaving to order of Secretary	97.50	65.00	.....	79.70	—4.74	237.46

MISCELLANEOUS ITEMS*

Year Books	$40.00
Dyed standards	14.98
Knitted tubing	19.66
Crock-meter cloth	3.86
Carbonizing reports	6.00
Dyestuff Reporters	.70
Buttons	4.50
Insurance rebate	13.35
Total	$103.05

Senior

M. Albright	C. C. Finney	P. M. Otto, Jr.
J. R. Berwick	J. Geduldiger	J. B. Sane
W. F. Black	F. W. Hartman	P. Soderdahl
J. K. Davis	H. Joyal	J. W. Timperley
S. V. Dougherty	M. L. Kesler	J. L. Volk
E. V. Durham	W. N. Kline, Jr.	E. H. Walker
H. H. Eager, Jr.	J. U. Manning	E. N. Zeuner
	H. C. Parish	

Junior

R. C. Andrews	R. H. Eckstein	H. A. Koller
S. J. Craig, Jr.	C. F. Gaddy	J. J. Moulson
R. S. Dingle, Jr.		R. W. Wood

Associate

S. L. Black	R. L. Ericsson	T. S. Nichols
E. A. Byrum	W. A. Manuel	R. V. Reece
J. M. Brennan	B. F. Marthens	W. J. Schleicher

Student

F. C. McQuillan	E. G. Simpson	A. J. Zawisza

The following were transferred from other classifications to Senior membership—I. M. Bethel, E. F. Ernst, L. Shapiro, W. F. Prien.

Respectfully submitted,

HAROLD C. CHAPIN, *Secretary.*

Nineteenth

ANNUAL MEETING AND CONVENTION

A. A. T. C. C.

COMMITTEES

General Convention Committee

CLARENCE NUTTING—EX OFFICIO
W. H. ZILLESSEN—GENERAL CHAIRMAN
JOSEPH A. BRYANT—VICE-CHAIRMAN

Program Committee

CARL Z. DRAVES—CHAIRMAN

Publicity and Exhibit Committee

H. P. SELYA—CHAIRMAN
John N. Dalton
Dr. Harold C. Chapin
R. E. Caffray
Herbert E. Wieland
Prof. E. R. Schwarz

Reservation and Registration Committee

EDWARD E. BELL—CHAIRMAN
M. P. Graham
John H. Grady
Edwin E. Buthmann
Frank Rizzo

Dining and Entertainment Committee

MICHAEL J. LANE—CHAIRMAN
Roland E. Derby
Joseph A. Bryant, Jr.
Fred A. Dushane
George O. Linberg
Harry Emmons

Reception Committee

K. H. BARNARD—CHAIRMAN
Alex Morrison
Hugh Christison
Frank E. Fleming
E. G. Goullaud

Sight-Seeing and Transportation Committee

CHARLES SCHMITT—CHAIRMAN
Delbert E. Ray
Gordon M. Thompson

Headquarters:
Copley-Plaza Hotel

SEPT. 15 and 16
BOSTON, MASS.

THE CONVENTION CITY

Photo, Courtesy, Convention Bureau, Boston C of C

FANEUIL HALL (CRADLE OF LIBERTY), BOSTON, MASS.
This hall was built in 1742 by Peter Faneuil and given to Boston as a town hall. It was burned in 1761 and rebuilt in 1763. It was the center of the Revolutionary movement in Boston and the Colonies. It was used by the British officers as a playhouse during the siege of Boston. It was enlarged in 1805 from Charles Bulfinch's plans. The Hall has many historic paintings and portraits. The armory on the third floor has a military museum and library.

Photo, Courtesy, Convention Bureau, Boston C of C

BUNKER HILL MONUMENT, MONUMENT SQUARE, CHARLESTOWN, MASS.
This is a granite obelisk 221 feet high, located on Breed's Hill, within the lines of the American redoubt which was the center of the Battle of Bunker Hill on June 17, 1775. It was begun in 1825 and dedicated on June 17, 1843. General Lafayette assisted at the laying of the corner stone on June 17, 1825. There is a winding stairway of 294 steps to the top. An admission is charged.

Photo, Courtesy, Convention Bureau, Boston C of C

OLD NORTH CHURCH (CHRIST CHURCH), 187 SALEM ST., BOSTON, MASS.
It is the oldest church in Boston, being built in 1723. From the belfry of this church on the night of April 18, 1775, were hung lanterns which signalled Paul Revere that the British troops were marching to Lexington and Concord. Admission to the church is free, but there is a charge to go into the belfry.

ANNUAL MEETING AND CONVENTION BOSTON, MASSACHUSETTS — SEPT. 15th and 16th

Cotton Broadcloth

(Continued from page 410)

loss of weight on desizing, resistance to abrasion, mercerization, and apparent reflectance contrast.

Standard methods of testing were used in determining yarn count, weight, and breaking strength (by both the raveled strip and the grab methods) [8, pp. 3-5]; the percentage of sizing material [8, p. 41]; and the percentage of shrinkage[9]. It was necessary to make departures from the standard method for determining shrinkage because of the equipment available. A soap solution of 70° C. was used instead of the recommended 100° C. The machine was not run continuously during the entire 60 minutes of testing, but was stopped between each change of water.

The size of the yarns (yarn number) and the thickness of the fabrics were measured as described by Morrison and Hays[10]. Ten determinations of bursting strength were made on 4-inch squares of fabric with the ball-burst attachment of the pendulum-type testing machine. Twist measurements of single yarns were made on a twist tester with a Smith attachment. By this method the yarn is untwisted and then retwisted until the initial tension is reestablished as signified by the closing of an electric circuit. Fifty determinations of 5-inch lengths were made for both warp and filling of each fabric. To determine the number of turns per inch used to combine the two separate strands of ply yarns, 25 determinations of 10-inch lengths were made on a precision twist counter[11]. Then the twist in each of these strands was determined with the Smith attachment in the same way as for the single yarns.

Fabrics to be tested for resistance to abrasion, mercerization, and apparent reflectance contrast were desized by an enzyme treatment [8, p. 42(d)]. Resistance to abrasion was determined by rubbing samples on the Wyzenbeek tester at three pounds pressure and four pounds tension, using a stainless iron wire gauze as the abradant. Five samples from each fabric were rubbed 10,000 times in the filling direction. Likewise, five samples were rubbed 20,000 times in the warp direction for all fabrics having single yarns with less than 180 yarns per inch in the warp and filling combined, and 30,000 times warpwise for all other fabrics having single yarns and for all those having ply yarns. The samples rubbed in the warp direction were tested for filling breaking strength, while those rubbed in the filling direction were tested for warp breaking strength (raveled strip method). A yarn count was taken on each strip before the breaking strength was determined.

The barium hydroxide absorption method as described by Edelstein[12] was used as a test for mercerization. This method is based on the fact that mercerized cotton absorbs more barium hydroxide from a dilute solution than does the unmercerized under the same conditions. One change was made in the procedure in that the samples were dried in a warm room instead of in a drying oven as recommended, but in addition were conditioned for four hours in a testing laboratory maintained at 70° F. and 65 per cent relative humidity. The dried samples were placed in flasks, the barium hydroxide added, and the flasks allowed to stand approximately two hours in the same laboratory. Standard samples were taken from a piece of single broadcloth with a 100 x 60 yarn count. This fabric was unmercerized, bleached, dried, and framed, but not calendered or finished in any way. The results are expressed as the ratio of barium hydroxide absorbed by the test samples to that absorbed by the standard unmercerized fabric. This ratio, multiplied by 100, is called the barium activity number.

Contrast-gloss measurements[13] are best suited to investigations of the luster of low-gloss surfaces such as those of broadcloth fabrics. Measures of gloss that average considerable areas of a fabric are indicative of the reflection distributions by the surface rather than by the yarns used in the fabric. These measurements are influenced by such factors as weave and finish. Changes of apparent reflectance contrast as a fabric is turned in its own plane seems more likely to give a correlation with the luster of yarns than does any single measure of gloss with the fabric in one position. Consequently, apparent reflectance contrast measurements, indicative of contrast gloss, were made using the multi-purpose photoelectric reflectometer as described by Hunter[14]. Values of the ratio of apparent reflectance for 45 degrees illumination and 45 degrees viewing to that for 45 degrees illumination and normal viewing are read directly on the instrument.

The fabrics for this test were dampened and then stretched while being dried so as to give a fairly smooth surface. Each sample was mounted over an opaque piece of white cardboard in a 4-inch embroidery hoop. It was placed before the large aperture of the instrument, rotated clockwise in its own plane through 360 degrees, and the readings taken for positions at which maximum and minimum values of contrast occurred. Two such positions were found for each fabric. The results reported here for each sample are the average differences between maximum and minimum readings.

RESULTS

The result of the analyses of the individual samples is given in Tables 1 to 3. In general, the filling yarns are somewhat finer than the warp yarns as shown by higher yarn numbers (Table 1), but they do not have higher twists. For single fabrics, the amount of twist in the warp yarns increases with the yarn number. No such relation was found for the corresponding filling yarns,

Table 1.-- ANALYSES OF 40 SINGLE COTTON BROADCLOTH FABRICS

Fabric number 1/	Yarn count		Yarn number		Twist		Weight	Thickness	Loss in weight on desizing	Shrinkage		Barium activity number	Apparent reflectance contrast
	Warp	Filling	Warp	Filling	Warp	Filling				Warp	Filling		
	Number	Number	1,000 yds. per lb.	1,000 yds. per lb.	Turns/in. and direction	Turns/in. and direction	Oz./sq.yd.	Inches	Percent	Percent	Percent		
Type 1-a													
A-1	103.4	55.8	27.989	34.051	23.5Z	22.0Z	3.16	0.0074	4.14	6.7	-0.1	96	0.052
A-2	81.8	57.6	24.289	34.048	22.2Z	29.9Z	2.84	.0064	10.89	6.5	3.7	104	.063
B-1	103.8	56.4	28.385	35.640	22.0Z	24.3Z	3.02	.0063	3.18	7.5	0.1	100	.069
B-2	103.0	57.6	25.471	40.196	22.4Z	26.2Z	3.00	.0071	2.40	6.6	0.6	101	.067
B-3	81.0	58.6	24.584	32.280	20.4S	27.9Z	2.90	.0065	10.44	6.0	4.6	97	.026
C-1	116.0	57.2	26.580	44.006	24.2Z	28.4Z	3.20	.0069	2.49	7.3	0.3	100	.088
D-1	115.4	55.6	27.927	34.574	23.3Z	26.6Z	3.16	.0065	0.64	8.7	0.0	97	.068
D-2	104.0	57.2	25.916	36.422	23.0Z	26.5Z	3.00	.0061	0.70	6.3	0.7	107	.054
E-1	116.4	61.4	26.293	32.563	24.4Z	21.4Z	3.60	.0101	1.98	0.9	-0.1	104	.074
E-2	116.0	59.2	27.134	32.116	25.2Z	22.5Z	3.42	.0093	2.16	2.6	1.3	96	.074
E-3	103.6	61.2	24.676	32.288	26.2Z	24.5Z	3.32	.0095	2.98	1.0	0.3	104	.030
E-4	81.0	57.6	26.250	31.082	23.8Z	23.1Z	2.90	.0063	14.37	5.0	4.4	107	.034
E-5	113.8	56.4	26.207	38.423	25.2Z	27.0Z	3.22	.0065	3.86	7.9	0.7	99	.099
E-6	102.8	58.0	30.551	41.665	20.6Z	27.2Z	2.96	.0064	1.84	5.8	0.7	98	.054
F-1	102.0	55.8	26.403	35.870	22.4Z	26.6Z	2.96	.0068	2.03	6.3	1.0	104	.060
F-2	119.2	58.4	28.620	40.808	23.0Z	23.8Z	3.16	.0067	0.71	6.3	0.2	103	.099
G-1	104.8	60.4	26.646	30.609	21.5Z	28.0Z	3.20	.0071	3.50	7.0	0.1	100	.054
G-2	103.4	58.0	27.778	34.097	21.4Z	23.4Z	3.00	.0065	1.17	6.3	1.8	101	.067
G-3	80.6	55.4	27.804	32.983	17.3Z	21.8Z	2.84	.0077	11.07	5.6	4.2	97	.032
G-4	81.4	55.2	23.877	36.305	18.6Z	29.5Z	2.86	.0075	12.55	5.3	3.3	104	.043
G-5	81.6	58.4	23.010	35.330	19.5S	32.2Z	3.08	.0061	15.11	5.8	3.8	99	.064
Type 1-b													
A-3	134.0	65.6	32.057	38.198	27.2Z	21.4Z	3.18	.0079	1.15	3.0	-0.1	112	.065
C-2	152.4	69.2	45.444	33.495	26.7Z	17.3Z	3.00	.0065	0.25	5.6	0.3	117	.041
C-3	132.2	66.8	32.887	35.950	24.8S	22.0Z	3.20	.0088	0.44	0.4	1.6	122	.128
C-4	133.0	64.0	33.900	35.987	25.2S	23.1Z	3.14	.0069	0.73	1.4	1.6	115	.132
D-3	140.2	59.4	32.178	34.617	23.8Z	19.9S	3.30	.0101	0.52	-0.8	1.0	122	.143
E-7	140.8	60.6	33.985	41.915	27.4Z	20.2Z	3.24	.0085	1.18	2.7	0.4	110	.098
E-8	138.0	55.4	33.589	31.120	27.2Z	25.9Z	3.16	.0060	3.23	5.6	1.0	118	.105
E-9	140.6	56.2	33.190	35.633	26.6Z	23.4Z	3.16	.0080	1.54	4.1	0.3	115	.078
F-3	138.0	58.8	32.462	39.762	28.7Z	23.6Z	3.12	.0097	1.13	3.4	0.9	100	.088
F-4	142.4	58.8	31.977	41.369	27.5Z	21.4Z	3.34	.0086	0.55	3.7	-0.3	119	.128
F-5	147.4	71.2	40.950	40.556	26.0Z	19.5S	2.96	.0075	0.27	3.8	0.6	116	.121
F-6	156.0	81.6	42.227	44.441	27.2Z	21.7Z	3.00	.0074	0.50	3.2	1.0	118	.050
G-6	134.0	67.2	33.762	39.281	20.9Z	17.3S	3.32	.0091	0.44	0.9	0.7	126	.139
G-7	133.6	63.8	34.736	37.633	21.2Z	20.4S	3.12	.0072	1.53	2.8	2.0	125	.152
G-8	142.0	58.4	34.616	35.109	24.6Z	17.3S	3.36	.0095	0.81	1.0	-0.2	122	.164
H-1	149.0	74.6	42.887	41.050	24.8Z	18.8S	2.90	.0086	0.22	1.0	3.2	129	.116
H-2	138.6	56.6	35.804	35.714	21.9Z	18.6S	3.10	.0090	0.23	1.3	-0.6	127	.147
H-3	131.0	65.6	33.672	37.344	21.5Z	19.3S	3.10	.0081	0.44	1.0	2.3	124	.132
I-1	141.0	60.6	33.852	36.542	21.6Z	18.6S	3.32	.0085	0.95	1.3	0.3	139	.167

1/ The letter in the fabric designation refers to manufacturer or distributor.

Table 2.--ANALYSES OF 11 PLIED COTTON BROADCLOTH FABRICS

Fabric number 1/	Yarn count		Yarn number		Twist				Weight	Thickness	Loss in weight on desizing	Shrinkage		Barium activity number	Apparent reflectance contrast
					Warp		Filling					Warp	Filling		
	Warp	Filling	Warp	Filling	Ply	Single	Ply	Single							
	Number	Number	1,000 yds. per lb.	1,000 yds. per lb.	Turns/in. and direction	Turns/in. and direction	Turns/in. and direction	Turns/in. and direction	Ounces per sq.yd.	Inches	Percent	Percent	Percent		
Type 2															
C-5	127.2	62.6	30.011	46.137	20.3S	23.7Z		20.6Z	3.16	0.0086	0.62	1.3	-0.1	148	0.125
C-6	126.2	59.8	30.697	45.864	19.6S	25.6Z		21.6Z	2.94	.0056	0.61	4.8	0.2	114	.105
I-2	112.2	99.4	25.094	36.933	13.0S	24.8Z		18.5Z	3.44	.0092	0.54	1.2	2.2	144	.134
I-3	109.4	45.8	26.589	13.424	12.6S	24.1Z		10.7Z	4.38	.0128	0.50	3.0	1.3	133	.046
Type 3															
I-4	151.4	72.8	44.968	40.387	15.1S	28.2Z	32.0Z	32.5Z	3.08	.0085	0.68	0.4	1.6	134	.014
I-5	169.2	80.8	42.017	48.043	15.5S	27.2Z	31.0Z	33.7Z	3.38	.0085	0.81	0.4	1.2	134	.058
I-6	157.4	76.2	39.696	38.635	15.6S	26.8Z	32.4Z	31.6Z	3.44	.0086	0.64	0.6	0.5	143	.042
J-1	148.8	72.8	40.404	41.530	16.2Z	23.8S	32.3S	33.4S	3.12	.0086	0.70	-0.9	2.0	146	.065
K-1	155.6	78.4	45.766	44.111	20.0S	28.8Z	19.5S	31.3Z	2.94	.0069	1.02			136	
L-1	174.0	88.8	50.029	40.598	19.3S	29.1Z	35.1Z	35.2Z	3.16	.0070	0.35	2.5	0.0	141	.019
M-1	123.4	58.6	28.486	31.938	17.4S	32.4Z	25.5S	33.7Z	3.50	.0097	0.64	1.1	3.1	145	.078

1/ The letter in the fabric designation refers to manufacturer or distributor.

although the distribution of the twists in these yarns is very similar to that in the warp yarns. However, for these fabrics there is less variation in the filling than in the warp yarn numbers. Twist is related to yarn number by the formula $TPI = M\sqrt{YN}$[15] where TPI equals turns per inch (twist), M equals twist multiplier, and YN equals yarn number on the cotton system. Consequently, if the factor M is calculated, there will be a greater range in values for filling than for warp yarns. These values vary from 3.0 to 4.8 for the warp and from 2.5 to 5.0 for the filling yarns.

As shown by yarn count, there are more warp than filling yarns to the inch. The ratio of warp to filling varies from 1.4 to 2.5 with an average value of 2.0. Since a ribbed effect produced by using approximately twice as many warp as filling yarns is an inherent characteristic of broadcloth, it cannot be a balanced fabric; that is, a fabric having approximately the same number and size

Table 3.--ANALYSES OF THE STRENGTH OF SINGLE AND PLY COTTON BROADCLOTH FABRICS

Fabric number	Breaking strength (strip)						Breaking strength (grab)						Bursting strength	
	New material		Standard deviation		Abraded material		Loss after abrasion		New material		Standard deviation		New material	Standard deviation
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling		
	Pounds	Pounds			Pounds	Pounds	Percent	Percent	Pounds	Pounds			Pounds	
Type 1-a														
A-1	43.9	18.5	1.3	0.5	19.5	11.6	56.2	49.1	51.3	19.4	1.1	0.8	38.6	4.1
A-2	50.5	21.5	1.5	0.9	5.1	6.6	88.0	70.9	52.0	24.3	2.6	1.0	42.3	6.9
B-1	56.7	20.1	2.3	1.2	27.0	18.3	49.9	14.1	64.3	17.1	1.4	1.5	42.9	5.6
B-2	57.0	18.3	2.7	1.0	45.1	19.6	29.6	18.3	62.0	19.8	3.4	0.6	39.3	3.6
B-3	50.1	22.6	1.6	1.8	9.4[1]	9.8	79.7[1]	71.7	54.8	25.6	0.8	2.2	49.4	4.6
C-1	57.8	18.2	2.3	1.3	40.0	14.3	35.2	30.2	68.8	19.7	2.0	0.7	43.5	3.4
D-1	72.3	23.4	2.6	1.6	56.4	23.7	13.0	6.7	80.4	22.9	5.4	1.5	47.8	3.9
D-2	61.5	18.6	2.3	1.1	24.0	16.8	55.4	24.7	68.6	21.2	3.3	1.0	45.9	5.4
E-1	64.7	24.1	2.1	0.8	60.2	30.1	9.2	-3.1	77.1	27.4	3.9	3.8	61.5	22.7
E-2	56.8	25.6	2.9	2.9	50.2	26.9	10.7	-9.3	64.1	28.8	3.6	2.0	45.6	12.6
E-3	56.4	27.3	1.8	2.4	24.8	18.2	56.6	30.5	61.4	29.5	1.3	2.8	51.4	12.8
E-4	46.2	22.2	1.6	1.4	10.1	0.0	77.8	96.3	51.4	22.5	1.4	1.3	38.4	5.8
E-5	60.3	17.4	1.0	1.4	53.5	20.1	15.2	2.0	70.1	19.0	2.5	0.5	41.1	3.1
E-6	58.8	20.7	2.3	0.8	42.6	17.1	31.2	25.6	66.6	24.3	1.1	1.5	50.6	5.5
F-1	58.1	20.1	1.3	1.1	48.1	21.8	16.5	12.8	67.5	18.9	1.8	1.2	42.7	2.6
F-2	74.6	20.6	2.4	1.0	62.8	24.7	15.6	6.9	84.6	21.6	4.2	1.6	52.7	4.1
G-1	59.0	22.5	1.9	2.0	41.8	19.4	27.3	23.9	68.8	26.1	2.9	2.1	54.8	6.3
G-2	70.7	28.1	2.6	1.5	62.8	27.1	8.7	12.0	84.2	26.7	2.6	2.0	56.8	5.7
G-3	44.5	20.2	1.0	0.8	18.0	6.1	57.0	71.4	49.4	24.4	1.6	1.8	39.9	4.8
G-4	48.8	20.8	1.6	1.1	16.2	7.3	64.8	64.4	55.0	23.5	1.6	2.5	46.0	4.8
G-5	51.2	22.1	0.9	1.4	12.6	11.5	74.0	44.4	55.2	25.4	2.3	1.8	48.0	4.8
Type 1-b														
A-3	69.1	30.9	2.4	2.4	12.4[1]	31.9	82.3[1]	4.8	83.5	30.4	3.8	2.0	58.3	5.6
C-2	69.9	33.2	2.4	1.5	59.0	32.4	13.4	12.0	78.4	35.7	4.9	2.0	59.0	4.7
C-3	74.6	33.1	3.1	2.6	56.1	27.0	24.1	17.2	73.4	37.5	7.4	3.1	63.8	14.2
C-4	68.4	30.3	2.7	1.0	54.6	28.4	24.9	21.8	78.8	31.4	3.6	1.0	53.2	3.2
D-3	74.2	25.7	3.2	1.7	41.0	23.3	49.9	13.0	82.7	31.8	6.0	0.4	78.8	15.9
E-7	74.8	24.7	2.7	1.1	54.9	23.3	29.4	18.0	83.4	31.4	3.9	1.2	74.1	14.6
E-8	30.8	13.9	2.8	2.5	16.6	14.2	72.3	7.2	38.0	18.7	3.4	3.8	33.9	2.8
E-9	83.0	23.7	1.6	1.5	70.8	23.0	10.0	2.5	89.1	30.7	7.1	1.8	50.8	5.8
F-3	62.4	20.7	1.8	0.9	53.3	23.3	16.5	-7.4	73.5	22.2	2.7	1.9	46.4	13.5
F-4	78.3	25.4	2.8	1.3	69.0	30.8	15.1	2.2	90.0	26.6	4.8	1.9	52.7	6.0
F-5	71.1	31.8	3.2	2.3	53.5	32.7	28.7	4.7	83.6	29.9	6.0	1.8	58.0	6.2
F-6	75.3	35.5	3.2	2.6	61.8	33.4	12.3	18.5	85.0	44.7	2.9	3.9	70.9	17.0
G-6	77.6	32.7	2.8	1.0	67.4	35.2	13.7	9.7	86.0	33.2	4.2	1.8	62.3	4.2
G-7	71.4	26.1	1.9	1.2	34.1	19.4	51.9	25.7	80.9	26.4	2.3	1.5	54.9	4.5
G-8	75.8	30.3	1.6	2.4	71.0	33.6	7.7	-0.9	87.7	31.9	5.8	1.3	57.4	7.7
H-1	69.0	32.2	1.8	2.7	43.9	29.4	39.4	11.4	74.5	33.9	6.2	2.5	67.7	15.3
H-2	83.6	30.4	3.1	2.3	43.4	26.3	46.6	14.3	89.1	31.2	5.0	1.9	62.7	11.8
H-3	77.3	30.9	2.8	1.1	50.3	28.5	38.0	8.1	86.6	32.5	6.1	0.8	56.1	8.6
I-1	67.2	22.2	2.5	0.8	41.7	22.6	41.9	10.7	78.6	19.1	3.4	2.3	51.2	17.1
Type 2														
C-5	108.2	29.1	4.9	2.0	4.8[1]	22.7[1]	95.7[1]	26.8[1]	110.0	29.7	7.1	2.0	54.5	3.7
C-6	110.9	29.7	3.3	2.0	61.8	27.2	43.2	16.8	108.4	32.4	7.5	0.8	62.8	5.0
I-2	95.4	23.0	1.6	1.0	39.8	20.4	56.0	14.3	104.8	27.8	2.4	2.0	54.3	10.3
I-3	83.3	73.9	2.4	4.6	12.4	76.8	84.2	-1.4	93.8	71.5	7.5	5.6	105.6	18.8
Type 3														
I-4	83.9	32.7	4.4	1.2	39.7	30.4	55.3	14.4	89.8	32.3	4.7	2.6	68.6	5.0
I-5	99.4	32.6	3.6	2.2	55.7	31.4	41.1	4.4	109.0	35.9	4.1	1.7	62.5	7.5
I-6	95.2	38.6	4.0	11.0	29.6	34.7	68.4	12.2	101.7	43.3	2.2	1.9	69.8	10.4
J-1	105.2	34.7	3.2	0.8	38.6	25.1	61.3	22.2	112.5	36.9	5.4	2.4	66.7	11.8
K-1	86.1	32.8	3.3	0.3	--	--	--	--	92.7	33.4	5.2	1.4	54.5	6.1
L-1	84.8	33.0	7.1	2.0	42.5	28.0	54.2	17.6	91.7	36.9	6.2	1.7	70.4	6.8
M-1	85.4	32.0	2.2	1.3	58.7	32.7	32.2	0.0	91.9	33.7	4.6	2.0	87.2	14.8

1/ Not given standard number of rubs.

of warp and filling yarns. The lowest count fabrics sold as broadcloths are nearly balanced in both yarn count and breaking strength, but they do not have a ribbed appearance. In fact, they closely resemble print cloth.

There is a slight trend toward a direct relationship between weight and thickness; that is, the thicker fabrics tend to be the heavier ones. No relationship exists between weight per square yard and loss in weight on desizing. The very low count fabrics have from 10 to 15 per cent sizing as compared with 4 per cent or less for all others.

The majority of fabrics had greater shrinkage in the warp than in the filling direction (Tables 1 and 2). Twenty-one of the fabrics were designated as having been preshrunk. For these the amount of residual shrinkage ranged from 1.0 to 4.0 per cent in the direction of greatest shrinkage; however, only three of them had more than 3.0 per cent. Of the 30 fabrics for which no designation concerning shrinkage was given, one could not be tested because of insufficient material, 7 had less than 3.0 per cent residual shrinkage, and the other 22 ranged from 4.5 to 9.0 per cent. Of these 22, fifteen had a residual shrinkage of more than 6.0 per cent. Thus, about half of the broadcloths had less than 3.0 per cent residual shrinkage, and a little over a fourth of them had more than 6.0 per cent. The fact that approximately half of the fabrics studied had enough shrinkage to cause some dissatisfaction among consumers illustrates the need for the labeling rules recently formulated by the Federal Trade Commission[16]. For example, fabric G-6 might well be labeled "Preshrunk —residual shrinkage will not exceed warp 1 per cent, filling 1 per cent, Commercial Standard CS59-36," while fabric G-5 might be labeled "Preshrunk—residual shrinkage will not exceed warp 6 per cent, filling 4 per cent, Commercial Standard CS59-36."

Edelstein[12] states that for the manufacturer and consumer a determination of the "degree of mercerization" of a sample of cotton must contain an integration of its strength, luster, and chemical reactivity; therefore any single test can show only whether the sample has been mercerized or not. In the same paper, Edelstein reported that yarns or fabrics from unmercerized cottons of different origins had a barium activity number of 100; commercially mercerized piece goods had values from 115 to 130, and commercially mercerized yarns had a value of 150.

In the present work, barium activity numbers from 96 to 148 were obtained for the broadcloth samples. Values

below 110 seem to indicate unmercerized samples, and all values of 110 or above indicate mercerization. One of the three fabrics with a value between 110 and 115 was designated as mercerized when it was purchased. The other two of these fabrics indicate that they are mercerized because their barium activity numbers fall into the second group of points on the graph (Fig. 1) that shows

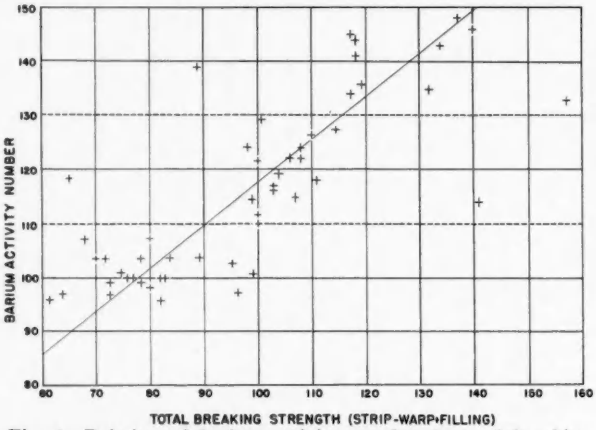

Fig. 1—Relation of barium activity number to total breaking strength (strip-warp plus filling).

the relationship between barium activity number and combined breaking strength of the warp and filling yarns by the strip method. The graph includes two very distinct groups of points, the first with barium activity numbers less than 110, the second with values between 110 and 130. A third group, which is rather scattered, has values greater than 130. In general, the barium activity values tend to increase with the combined breaking strength of the warp and filling yarns. This is expected since breaking strength has been found to increase with mercerization[17].

Forty-five of the broadcloth samples studied were bought directly from manufacturers. If the barium activity numbers for these samples are arranged according to manufacturer (designated by C through M), there is a definite grouping. One group includes the unmercerized samples. Another group, the mercerized samples, have very nearly the same values for any given manufacturer; except for C, where one value is much larger than the others. Taken as a whole, there seems to be two groups of values for mercerized samples; namely, 110 to 130 and 130 to 150, as already shown in Figure 1. With the exception of fabric I-1, all samples with activity values greater than 130 are plied fabrics. Furthermore, only one plied fabric (C-6) had a value less than 130.

In general, then, the plied fabrics tested have higher barium activity numbers than single ones. This would seem to indicate that ply fabrics are more completely mercerized than single ones, probably because of greater surface per unit weight present for absorption during the mercerization process or because of different treatments for single and plied fabrics. The two exceptions (I-1 and C-6) would seem to indicate that single and plied fabrics treated in a similar way would give the same activity values. For example, the single fabric with a activity number greater than 130 was one of six fabric all obtained from one manufacturer (I). The other fi were plied and the activity numbers ranged from 133 t 144 for the group of six. A similar situation existe for the plied fabric with an activity value less than 13 It should be remembered that the unmercerized sampl used in all the barium activity determinations was a singl fabric, so that any difference in absorption of hydroxid by single and ply fabrics would enhance the activity valu of the ply fabrics. However, the information obtained i the present work was not sufficient to fully explain th higher activity values for the plied fabrics.

No definite relationship could be found between th apparent reflectance contrast values and any other prop erty of the broadcloth fabric. These values plotted agains the barium activity number (Fig. 2) show the impossi

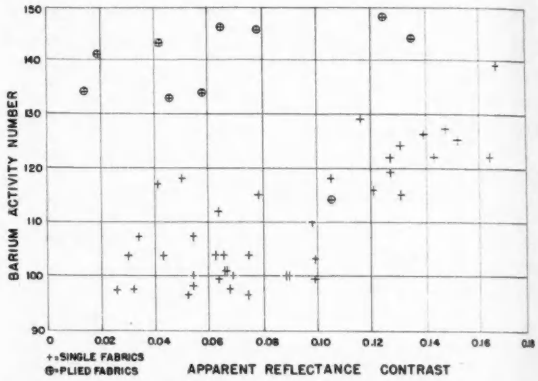

Fig. 2—Barium activity number plotted against apparent reflectance contrast.

bility of using them as a reliable indication of the mercerization of the fabrics. However, for the single fabrics there is a slight trend in the values; that is, the values for luster tend to increase with the barium activity numbers. For the plied fabrics, there is no indication of such relationship. Doubtless too many variables are involved in such a luster measurement for it to be of any use in giving information concerning the mercerization of fabrics either when used alone or together with other measurements.

Breaking strength values (Table 3) by both strip and grab methods increase in general with the number of yarns per inch. They are considerably greater in the warp than in the filling direction, as might be expected, since there are more warp than filling yarns to the inch. Nevertheless the breaking strength per yarn, or strength-index, is greater in the warp than in the filling direction. This means that the warp yarns individually are stronger than the filling yarns. In general there is more variation in the individual breaking strength values in the warp direction than those of the filling for any given fabric, as indicated by the standard deviations.

In general, the grab values are approximately two pounds larger fillingwise and seven pounds larger warp

wise than the strip values. For the individual samples, there is considerable variation in the relation of grab to strip. In fact, there are a number of cases where the strip value is greater than the grab. If the average grab value for the entire 51 fabrics is substituted in the formula given by Mereness[18] for the strip-grab relation of cotton shirting and sheeting, the calculated strip value checks the average experimental value within 3 pounds.

The percentage loss in breaking strength after the fabrics have been abraded is the best indication of how they will stand up under wear of this type. As shown in Table 3, there are large differences in values between the fabrics, the variation in the warp values being greater than in the filling; but in general the loss in warp breaking strength is considerably greater than in the filling. This is due, no doubt, to the fact that the close packing of warp yarns forms a protective covering for the filling yarns in the fabrics with many more yarns in the warp direction than in the filling. On the other hand, the lowest count fabrics had as large changes in filling breaking strength as in warp strength, since they have nearly the same number of yarns in both the warp and the filling direction.

The variation in bursting strength values for a given fabric is much greater than in breaking strength values. In numerous cases, two groups of values for bursting strength were obtained for each sample depending upon the manner in which the fabric broke. In general, the bursting strength is very close to the average of the warp and filling breaking strength by the grab method.

COMPARISON OF THE DIFFERENT GROUPS OF BROADCLOTH

From the data obtained in the analyses of the 51 representative samples, it is evident that broadcloth can be classified according to the type of the yarn; namely, single (having single yarns in both warp and filling); mixed-ply (having 2-ply warp and single filling yarns); and double-ply (having 2-ply yarns in both warp and filling). The 40 single fabrics can be subdivided into two groups according to whether the combined number of warp and filling yarns per inch is (a) less than 180, or (b) equal to or greater than 180. For convenience, these two groups are designated here as Type 1-a and Type 1-b, respectively; mixed-ply as Type 2; and double-ply as Type 3. The six lowest quality fabrics of Type 1-a have so few warp yarns per inch that they do not have the ribbed effect characteristic of broadcloth. Some retailers have recognized that the use of the term "broadcloth" to describe such fabrics is misleading to consumers and have attempted to reduce the confusion by advertising and labeling fabrics with higher warp yarn counts as "genuine broadcloth."

The four classes of broadcloth include two groups of single and two of plied fabrics. Volume business is apparently in the single fabrics, as it was possible to obtain many more samples of these than of the plied fabrics. Unfortunately, only four mixed-ply fabrics (Type 2) could be obtained for this study. One of these is very different in construction from all other broadcloths analyzed, as may be seen from its yarn count and breaking strength values (Tables 2 and 3).

According to Table 4, plied fabrics are slightly heavier than the single ones. Fabrics of Type 1-a are lightest of all and contain the largest amount of sizing material. The large variation in values of percentage sizing for this group is due to the extremely large values for the lowest count fabrics. Double-ply fabrics (Type 3) and single fabrics of Type 1-b are comparable as to weight and amount of sizing material present, and the variations of these values within the group. Fabrics of Type 2, the mixed-ply group, are heaviest of all, but the amount of sizing they contain is the same as the other plied fabrics (Type 3). The variation in values of weight within groups is much greater for Type 2 fabrics than for the other three groups.

Fabrics of Type 3 have the highest yarn counts and yarn numbers, with Type 1-b next, then Type 2, and Type 1-a having the lowest yarn counts and numbers. Type 3 and Type 1-b fabrics have warp and filling yarns of nearly the same size as shown by yarn number; whereas for Type 2 and Type 1-a groups the filling yarns are finer than the warp yarns.

There was greater shrinkage in fabrics of Type 1-a than in those of the other groups. This is due possibly to the lack of any preshrinkage treatment. Only three of these fabrics were designated as preshrunk, whereas the majority of fabrics in the other three groups were designated as having undergone some kind of preshrinkage treatment.

Breaking strength and bursting strength values are lowest for Type 1-a, next for Type 1-b, then Type 3, and are highest for Type 2 fabrics. In the single fabrics, there is greater variation among the filling breaking strength values for Type 1-b than for Type 1-a. Type 2 has extremely large variation in filling breaking strength values because of the unusually high fillingwise breaking strength for fabric I-3. Likewise there is extremely large variation in the bursting strength values for Type 2.

According to the barium activity numbers, Type 1-a fabrics are not mercerized, whereas in general, all the

Table 4.--AVERAGE VALUES AND STANDARD DEVIATIONS FOR THREE GROUPS OF COTTON BROADCLOTH FABRICS

Class	Weight		Yarn count				Breaking strength (strip)				Breaking strength (grab)				Loss in weight on desizing	
			Number		Standard deviation		Pounds		Standard deviation		Pounds		Standard deviation			
	Ounces per sq. yd.	Standard Deviation	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Percent	Standard deviation
Type 1-a	3.1	0.2	101	58	14	2	57	22	9	3	65	23	11	4	5.6	4.9
Type 1-b	3.2	0.1	140	64	7	7	72	28	7	5	81	30	8	6	0.8	0.7
Type 3	3.2	0.2	154	76	16	9	91	34	8	2	98	36	9	4	0.7	0.2

Table 5.— PROPOSED SPECIFICATIONS FOR THREE GROUPS OF COTTON BROADCLOTH FABRICS (FINISHED)

Class	Yarn count (minimum)		Weight per square yard		Breaking strength (minimum)				Loss in weight on desizing (maximum)
					Strip method		Grab method		
	Warp	Filling	Minimum	Maximum	Warp	Filling	Warp	Filling	
	Number	Number	Ounces	Ounces	Pounds	Pounds	Pounds	Pounds	Percent
Type 1-a	100	54	3.0	4.0	52	18	56	20	4.0
Type 1-b	132	58	3.1	4.0	66	22	76	24	2.0
Type 3	146	72	3.1	4.0	82	30	90	32	1.0

other fabrics are mercerized. The variation in values is about the same for the Type 1-b and Type 3 groups, but greater in Type 2 because of the extremely low value for fabric C-6. The smallest amount of variation is in the unmercerized group (Type 1-a), as would be expected.

If resistance to abrasion is rated according to the percentage of change in breaking strength, then from greatest to least change in warpwise breaking strength, we have Types 1-b, 1-a, 3, and 2, and from greatest to least change in fillingwise breaking strength, Type 2, 1-b, 3, and 1-a. Type 1-b fabrics definitely have the highest rating, with Type 3 next, and Types 1-a and 2 lowest and very nearly the same. It should be noted that the magnitude of all values of changes due to abrasion for Type 1-a fabrics is increased by the six low count fabrics. If these were not included in the averages, values for Type 1-a would be fairly close to those for 1-b. The results for all groups indicate that abrasion tests should be standardized and correlated with other physical properties and with actual wear.

DEFINITION AND SPECIFICATIONS

On the basis of these results, the Bureau of Home Economics recommends that the name "cotton broadcloth" be restricted to those fabrics which have a weight of at least 3.0 ounces per square yard, a breaking strength (strip method) of not less than 52 pounds warpwise and 18 pounds fillingwise, and at least 100 warp yarns to the inch and approximately one-half that number of filling yarns, thus giving a characteristic ribbed effect. This definition would exclude application of the term "broadcloth" to fabrics now on the market with yarn counts around 80 x 60 and therefore without the ribbed appearance.

If broadcloth were defined in this manner and sold on the basis of a classification into single, mixed, and double-ply groups, the consumer would be aided in the choice of these fabrics. However, to obtain fabrics in the different groups that will give reasonable service, additional information concerning their characteristics is necessary. Some essential requirements are given in the specifications (Table 5) set up for Types 1-a, 1-b, and 3. These include the number of yarns per inch, weight, breaking strength (strip and grab methods) and loss in weight on desizing. Not enough samples for Type 2 were analyzed to warrant any satisfactory specifications for this group.

The proposed specifications were obtained by considering the average values and standard deviations given in Table 4, together with a graph of the distribution within the group of the values for each property. Figures 3 and 4 are typical distribution chart (yarn count and grab breaking strength). There is considerable overlapping of values in the distribution for the different groups, but there is also a definite grouping of values in every case.

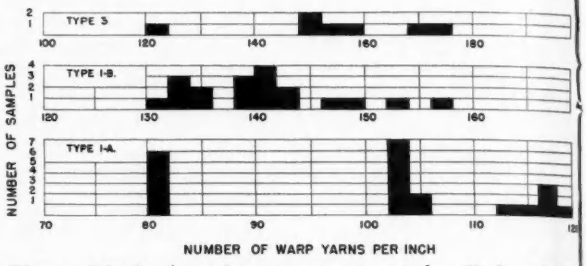

Fig. 3—Distribution of warp yarn count for 47 broadcloth fabrics.

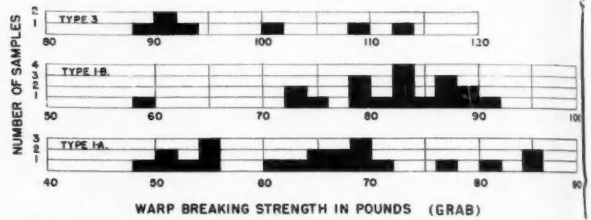

Fig. 4—Distribution of warp breaking strength (grab method) for 47 broadcloth fabrics.

Fabrics excluded from Type 1-a by these specifications, other than the six lowest counts, are numbers A-1, B-1, E-5, and F-1. However, small changes in manufacturing would enable two of these to meet the requirements.

Nine fabrics meet all the requirements proposed for Type 1-b, while five others fall below in only one respect and by very small amounts. Fabrics K-1 and M-1 are excluded from Type 3.

Except for one addition (maximum weight), the specifications proposed here for single fabrics were submitted in March, 1937, to the American Society for Testing Materials and have been accepted as Tentative Specifications[19].

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(Concluded on page 439)

A Specialized Treatment of

Discarded Paper-Maker's Felts

and a Possible Method of Conditioning for Reclaiming the Wool

An Original Investigation

LEO GLEKLEN

INTRODUCTION

IN the manufacture of paper, either newsprint, or the finer grades of book paper, paper-maker's felts play an important part. These felts, made from wool fiber, generally of high quality, serve primarily for blankets or conveyors.

In the manufacture of ground wood pulp*, which is finely divided wood without chemical treatment, the felt is used to convey the so-called "cream" (the ground wood pulp and water mixture) from the wet press machine to the finishing rolls resulting in the "wet ground" pulp or mechanical pulp.

These endless felts are important parts of the Fourdrinier machine, in which the felt carries the wet sheet of pulp while it is still weak.

The felts are also used to carry the paper over the drying cylinders, and are also found in a six-roll calender where three rolls are covered with felt in order to grip the paper.

In the manufacture of newsprint, a combination of chemical pulp, such as a sulfite pulp and a ground wood pulp are mixed with rosin size and clay, and then aluminum sulfate or alum is added to the "cream" to precipitate the rosin on the fibers. The rosin size is made by dissolving rosin in soda ash and fixed in an insoluble form by the addition of the alum.

Thus it can be seen that the felts which convey the pulp and "cream," must be able to withstand the action of the various chemicals and finishing compounds used in the manufacture of the paper.

During the period of use, these felts become worn and unfit for further usage, so that they are eventually discarded and replaced.

These paper-maker felts basically are all wool fiber, and if properly conditioned can be reworked into wool for the shoddy trade. The greatest difficulty up to the present time has been to get these felts into the proper condition for reworking, which necessitated the removal of the rosinous material from the wool, so that eventually the wool would be soft and fluffy, instead of harsh and needle-like to the hand.

Since at times there is an abundance of these paper-maker's felts on the market, and since there is an economical value to the wool, its basic constituent, it is quite evident that an investigation of the conditioning and processing of these paper-maker's felts would be of the utmost importance and value to the wool and re-worked wool manufacturers.

It is also quite evident that in a procedure of this kind, it is necessary to process the material in the most economical manner.

Many of the shoddy plants at the present time, condition and process paper-maker's felts, but the majority of these plants seem to ignore the fact that the rosinous character of the felts is what is causing the harsh needle-like feel to the wool after it is processed.

The color of the finished processed felt must also be as near white as possible in order to derive the maximum value from the reclaimed product.

Since the color of these discarded felts vary from a light yellow and tan shade to a dark brown color, in order to obtain a fairly white stock, the felts must be stripped or reduced in color without damaging the fiber.

This again necessitates the treatment of the felts chemically without impairing the value of the wool fiber.

According to David Blanchard in the May 27, 1937, issue of the *Paper Trade Journal* on page 22, he claims that in the care of new felts, a material of extremely fast wetting and penetrative power, combined with low alkalinity such as their "Feltex" is used. That product has the power of not forming any insoluble soaps in conjunction with lime, alum, or similar compounds which might be present in either the water or the loading and which do react and cause waterproofing of the felt.

He also claims that there are conditions where the old style alkaline, soap-type cleaners show an advantage, and are particularly evident where the felt becomes impregnated with certain color pigments. He also claims for that purpose, they have a low-titer type soap which rinses out freely in cold water.

According to R. W. Mitchell, in the June 13, 1935, issue of the *Paper Trade Journal*, he claims that sodium metasilicate, sometimes recommended in advertising for felt washing, is extremely destructive to wool.

Trisodium phosphate, he claims, is too alkaline to be a proper material for felt washing, because even when prop-

*(Industrial Chemistry—E. R. Riegel—Chapter 22—page 255—Chemical Catalog Company.)

erly used, there is considerable weakening and harshening of the wool fibers. He also claims that laundry research has indicated that the optimum pH for detergent processes is around 10.4-10.6. Soaps, he claims, are much better washing agents than alkalies as they have greater penetrative effect and greater dirt suspending value, and alkaline solutions alone have no wetting or penetrative effect, which in turn are proportional to the surface tension of the solutions.

The presence of some alkali in the soap solutions reduces the amount of hydrolysis of the soap, and cuts down the adsorption of acid soaps by the fiber.

In the carings of new felts, Mitchell says that sulfonated oils are beginning to be used more, a sulfonation renders the soap free from the precipitation of insoluble soaps in the presence of hard or alum-treated water, and diminishes the hydrolysis of the soap, with the result that less of it is adsorbed by the wool fiber, so that there is increased solubility and rinsibility. He says also that properly selected sulfonated soaps with moderate amounts of mild alkali forms very satisfactory felt washing material.

Some people have used acid such as 1 per cent muriatic acid to remove lime soap which build up in the felt, but this is a harmful practice because of the harshening effect on the wool and the corrosive action on the machine.

EXPERIMENTAL WORK

In the following experiments, the author will endeavor to attempt a more successful conditioning of the discarded paper-maker's felts than has previously been obtained.

Samples of discarded paper-maker's felts filled with the usual amount of rosin, etc., were obtained from one of the shoddy dealers handling this type of material and prepared for laboratory purposes. Three colors of felts were obtained; namely, a yellow, straw-colored felt, a light tan felt, and a very dark tan felt.

These samples were cut up into 10-gram pieces, so as to facilitate the laboratory procedures.

Experiment 1

(*In the following, all percentages are based on the weight of the material.*)

Ten-gram samples of each of the 3 types of felts were immersed in 200 c.c. of water, equivalent to 20 times the weight of the goods, 2 per cent of commercial acetic acid 56 per cent added, the material stirred about in the solution and allowed to remain 25 minutes at about 130° F. The samples were then washed under running water and dried by means of the warm air blower.

To each of the 10-gram samples of felts, immersed in 200 c.c. of water, 2 per cent of commercial formic acid was added, the material stirred, and allowed to remain 25 minutes at 130° F., and then washed under running water and dried by means of a warm-air blower.

Three more 10-gram samples were taken, and each immersed in 200 c.c. of water at 130° F. for 25 minutes with 2 per cent of a "mixed acid" made by several chemical manufacturers and usually containing varying proportions of acetic, formic and sometimes lactic acid. The samples were then removed, washed and dried by means of the warm air blower.

The samples were then examined for color and feel. It was found that the color did not change in any of the felts, but that the samples treated with the "mixed acid," did not feel so hard in handle as before treatment and that the formic-acid-treated samples were next best, and the acetic-acid-treated samples were the least best.

Experiment 2

Several 10-gram samples of each of the felts were treated with 2 per cent of the "mixed acid" at 130° F. for 25 minutes, washed under running water, and dried by means of a warm air blower.

These samples were then ready to be used in the following experiments.

Experiment 3

To each of the treated 10-gram samples of the 3 types of felts, in a 20 to 1 liquor ratio, 2 per cent of soda ash (58 per cent), and 10 per cent of a red-oil base detergent of approximately 30 per cent soap content and 5 per cent of a sulfonated castor-oil penetrant were added, and the whole mixture brought to a boil, and boiled for 30 minutes. The samples were then washed and dried by means of the warm air blower.

The samples were then observed, and in each case, it was found that the felts were softer to the feel, fluffier, had more life, and that the harsh, pin-like rosin feel had disappeared entirely. It was also observed that the color in each case after the boiling treatment had lightened considerably, and the straw-colored felt was now a pale yellow, the tan felt, a very light tan, and the darker tan felt very much lighter in color also.

Experiment 4

Several of the 10-gram samples of the 3 types of felts were taken, given the "mixed acid" treatment and the boiling treatment as of Experiment 3 in order to prepare them for a strip test to observe a change of color, if any.

Experiment 5

Each of the 10-gram samples treated as in Experiment 4 were taken, immersed in 200 c.c. of water, 4 per cent of sodium hydrosulfite and 1 per cent of acetic acid 56 per cent added, brought to a boil, and boiled for 20 minutes. The samples were then washed and immersed in a neutralizing bath at 120° F. containing 3 per cent of commercial ammonia for 15 minutes. The samples were then washed and dried by means of the warm air blower.

An observation showed that the straw-colored felt was now a light cream color, the tan felt was now much lighter in shade, and that the darkest felt had now lightened in shade to a marked degree. The handle and feel of the felts had not changed to any marked degree, but were not as soft as before stripping.

Experiment 6

A practical test was now made of the previously conducted experiments.

A 50-pound quantity of paper-maker's felts were taken, placed in a small open vat sufficient to hold the material,

enough water run in to hold the material, 2 per cent of the "mixed acid" added, and the material allowed to remain at 130° F. temperature for 25 minutes. The material was then washed, 2 per cent of soda ash (58 per cent), 10 per cent of the red-oil detergent, and 5 per cent of the sulfonated castor-oil penetrant added, the material brought to a boil, and boiled for 30 minutes. The felts were then washed. Now, 4 per cent of sodium hydrosulfite, and 1 per cent of acetic acid 56 per cent was added, the bath brought to a boil, boiled 20 minutes, and then washed. The material was then neutralized with 3 per cent of ammonia at 120° F. for 15 minutes. The material was then washed, dried in a regular raw-stock drier, garnetted, and then carded on a regular card.

The material from this practical test was then observed and found to be a light grey color, soft and fluffy to the feel, and of now considerable value economically to the trade.

CONCLUSIONS

1. Mixed acids, containing organic acids tend to break down the rosin size and alum which is used to precipitate the rosin on to the fiber. By breaking down the sizing, the material is in better condition to receive further chemical treatment.

2. Sulfonated castor oil, and a red-oil detergent have a tendency to penetrate and soften the wool fiber in the felt and thereby increase its economic value.

3. The soda ash used in conjunction with the red-oil detergent and penetrant serves not only to increase the alkalinity of the bath, but also to help prevent adsorption of acid soaps on the fiber by reducing the hydrolysis of the soap as stated by R. W. Mitchell.

4. Stripping aids in reducing the color, but does not increase the softness of the felt. If possible, the stripping should be avoided.

It might be noted that in the future, any further investigation with respect to different types of sulfonated oils used with paper-maker's felts would aid materially in cheapening the cost of processing those discarded felts.

Incidence of Shrinkage—

(Concluded from page 409)

cent, were described accurately within the tolerances permitted in this report.

(7) Sales statements that fabrics were pre-shrunk or non-shrinkable were higher in percentage of inaccuracy than were those representing fabrics as not pre-shrunk or shrinkable.

Most of the fabrics used in this study were collected before the Trade Practice Rules regarding the shrinkage of woven cotton goods had been promulgated. Even so, only 10 of the 301 launderable fabrics in the study were described as to their pre-shrunk character in writing. The study therefore shows the desirability of extending the application of pre-shrinking treatments and descriptions to a larger proportion of the cotton fabrics on the market. The desirability of considering the shrinkage tendencies of fabrics intended for drycleaning also is seen, as well as the need of designating the residual shrinkage of these fabrics on labels attached to them.

Cotton Broadcloth—

(Concluded from page 436)

[7]Lucile Marker and Katherine Cranor. The wearing quality of nine white cotton fabrics as determined by their physical characteristics. Amer. Dyestuff Reptr. 27: 257-260, 284, 1938, illus.

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[10]Bess Viemont Morrison and Margaret B. Hays. Proposed minimum requirements of 3 types of upholstery fabrics based on the analysis of 62 materials. U. S. Dept. Agr. Cir. 483, 1938, 28 pp., illus.

[11]Haven, George B. Industrial fabrics. Ed. 2, 1938, pp. 278-283, illus. New York: Wellington Sears Co.

[12]Sidney M. Edelstein. A test for mercerization in the presence of dyes. Amer. Dyestuff Reptr., 25: 186-190, 1936, illus.

[13]Richard S. Hunter. Methods of determining gloss. Natl. Bur. Standards Jour. Reserach 18: 19-39, 1937, illus. (Reprinted as Research Paper RP 958.)

[14]Richard S. Hunter. Problems in the development of a multipurpose reflectometer. Paper presented at meeting of Optical Society of America, March 5-6, 1937. Abs. in Jour. Optical Soc. Amer. 27: 225, 1937.

[15]F. T. Pierce. The measurement of the mechanical properties of cotton materials. Jour. Textile Inst. 14: T161-T182, 1923.

[16]Federal Trade Commission. Trade Practice rules: shrinkage of woven cotton yard goods, 1938, 4 pp. [Mimeographed.]

[17]S. M. Edelstein. A study of the mercerization process. Amer. Dyestuff Reptr. 25: 458-466; 724-726, 1936; 26: 423-427, 1937.

[18]Harry A. Mereness. Breaking strength of dress fabrics: relation of strip to grab tests results. Textile Research 8: 165-167, 1938.

[19]American Society for Testing Materials. Tentative specifications for single-ply bleached cotton broadcloth. Amer. Soc. for Testing Materials Proc. 41 (Vol. 38, Pt. 1): 1157-1158, 1938.

TRADE NOTES • NEW PRODUCTS

OBITUARY

THOMAS LECLEAR

Thomas Leclear, chief chemist of the Celanese Corporation of America, died in his office on July 24th of a heart attack. He was 63 years old. For a number of years he was with the Fraser Chemical Company in New York. His widow and a daughter survive.

• NEW DISCHARGE PRINTING PROCESS

Development of a process for the discharge printing of fabrics made with Celanese rayon yarns was announced recently by Celanese Corporation of America.

The development marks the surmounting of one of the most difficult and stubborn problems in the commercial printing of fabrics made with Celanese yarns and is said to open the way to a tremendous increase in the use of these fabrics. One of the chief increased uses will be in street-wear garments for which fabrics with light-colored prints on dark grounds—produced by discharge printing—are preferred. Up to the present, the use of Celanese fabrics in this important field has been limited.

The new process is patented by Celanese Corporation and will be made available to users of the company's yarns.

It has been possible to discharge print fabrics such as Celanese by changing the

chemical structure of the yarn to permit the taking of cotton dyes, but this weakened the fabrics' wet strength to a considerable degree. The new Celanese process does not change the chemical structure of the Celanese yarn and therefore the fabrics retain their original strength.

• JOINS ROYCE

Royce Chemical Company, Carlton Hill, N. J., manufacturers of chemicals and soluble oils for the textile, tanning and cosmetic industries, announces the appointment of Louis A. Oberly as direct representative in the Middle West, with headquarters in Chicago.

LOUIS A. OBERLY

Mr. Oberly is a graduate chemist of the Missouri School of Mines and has supplemented this training by advanced courses in Washington University and Chicago University. He has been affiliated with the Hart & Harrington Company of Chicago.

• QUARTERLY PRICE LIST

The Quarterly Price List of the R & H Chemicals Dept., E. I. du Pont de Nemours & Co., Inc., for July, 1939, has recently been distributed. Featured among the items of current interest are peroxides for bleaching. Copies are available upon request.

• CARO-GANT FOLDER

A folder has recently been issued by the Hart Products Corp., 1440 Broadway, New York City, on Caro-Gant, described as the "Original 100% Active" warp dressing. The folder gives complete details regarding the product and copies are available upon request.

• CIBA REVIEW

Ciba Review, Number 23, July, 1939, has recently been issued. Featured in this issue is "The European Carpet." Contents are described by the following titles of articles: The Carpet as a Symbol of Power; The Earliest European Carpets; Carpets in the Turkish Fashion; The Beginnings of the Modern Carpet Industry; The Technique of Modern Carpet Manufacture in Europe; Carpets in European Peasant Art; Historical Gleanings; Scientific Notes. A supplement is included on "Colors for Nitrocellulose Lacquers."

• NEW NOPCO BUILDING

Plans for a 5-story brick or concrete building, to house manufacturing equipment which will provide additional facilities for the production of industrial chemicals and processing oils, were approved recently by the Executive Committee of the National Oil Products Company, Harrison, New Jersey.

Announcement of the new building, to be erected by winter, was made by Charles P. Gulick, Chairman of the Board of the Harrison firm. Mr. Gulick said the new structure was necessary because of the need for increased manufacturing facilities to produce new and improved industrial chemicals and processing oils recently developed at their own research laboratories.

The building will cost between one hundred fifty and two hundred thousand dollars. Wherever possible, New Jersey labor, supplies and contractors will be used in erecting the plant addition in conformity with company policy to employ these facilities in communities where their plants are located.

The new building will be located on the Passaic River site of the National Oil Products Company, at Harrison, New Jersey.

Information concerning NEW PRODUCTS for publication in our issue of September 4, 1939 must be sent IMMEDIATELY!

CLASSIFIED

WANTED: Graduate chemist, chemical engineer, or equivalent for research work. Under 33 years of age. At least three years' experience with dyestuffs. Prefer practical experience in dye testing and dyeing with sulfurs, vats, acids, and direct colors. Give full details as to age, experience, and salary expected. Write Box No. 194, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Finishing plant chemist. Ten years' experience with large dyestuff company and in cotton dyeing and finishing plant, including five years dyestuff and chemical purchasing. Age 34. Married. North preferred but not essential. Write Box No. 195, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Young man, knowledge of chemistry, dyehouse, textile and commercial experience, seeks position with chemical or textile firm. Write Box No. 196, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

WANTED: Chemist with practical dyeing and finishing experience, one who has experience on plied yarns and other fabrics, capable of assisting superintendent of large dyeing firm, must also understand costs. State experience and salary. Write Box No. 197, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

WANTED: Dyer with plied yarn experience, state experience and salary. Write Box No. 198, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Dyer with 25 years' practical experience of dyeing of silk, rayon and acetate. Able to take full charge or supervise all operation of dyeing, laboratory praxis, expert in dyeing of fast colors. Best references, desires position as Dyer, Supervisor or Demonstrator. Will go anywhere. Write Box No. 199, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Young textile chemist. Graduate chemistry and dyeing department, Philadelphia Textile School, desires position in New York or New Jersey concern. Fine practical experience in the dyeing, finishing and printing of all fibers. Knowledge of cost, procedure and machinery involved. Specialties, backfilling and pile fabrics. Good references. Now employed. Salary secondary. Write Box No. 200, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.